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For convenience most of the individual graphs are placed at the back.

Israel Gordon. M.D. 1935.

THE SENSATION OF VIBRATION, WITH SPECIAL REFERENCE TO ITS CLINICAL SIGNIFICANCE.

The sensation of vibration is the subjective experience of an individual when a series of rapidly repeated stimuli are applied to certain of his sensory end-organs, probably those of touch, pressure and passive movement, and the sensation is recognised by him as a continuous tremor. The sensation is evoked by applying a tuning-fork to his skin, preferably just superficial to a bony prominence.

The study of the sensation of vibration, although it involves no instruments nor technique that could not have been available for hundreds of years, has only been developed within the last fifty years, and even to-day very little advantage is taken by the clinician of the exact and quantitative method of estimation of the vibratory sensation which is now available.

Summary of Previous Work.

Rumpf (29.) was probably the first to make an exact study of the sensation. He first tried to study it by means of a faradic current, with alternations of 32 per second, then by rolling a four-edged ruler rapidly along the skin surface. He eventually studied the sensation with a series of 14 tuning forks, with rates of vibration varying from 13 to 1000 per second. He found the finger tip to be more

sensitive than the forehead, and came to the conclusion that the sensation was confined to the skin, and transmitted by the cutaneous nerves.

A few years later the subject was developed by Treitel (34). He used only one fork, of 128 vibrations per second; it had a foot-plate of horn, and the amplitude could be varied by means of weights that could be moved along the prongs, which were 13 cms. long. He believed that the sensation was distinguishable from that of pressure and touch, and that it arose in the soft tissues. He stated that the vibrations could be felt after the tuning fork had stopped. He also noted the characteristic diminution of the sensation in tabes.

The next advance was made by Gradenigo (14) working mainly from an otological point of view. He developed the tuning fork bearing the Gradenigo triangle. A small triangle was impressed on the lateral side of the prong of a tuning-fork, and appeared double, the one image overlapping the other, when the fork was struck. This overlap increased with diminution of amplitude of the prongs, and could be measured by a series of black lines, as seen under a magnifying glass.

Egger (8) in the same year worked with a series of three tuning forks, with vibration rates of 128, 512 and 2048 per second. He found that a rate of 128 per second was the best felt, and one of 2048 per second quite imperceptable. He was the first advocate of the theory that

the sensation was perceived by end-organs in the bone, periosteum, ligaments and joint capsules, and called the sensation "la sensibilité osseuse." He was so convinced of this that he described islets of anaesthesia on the long bones and stated that in cases of hemianaesthesia one side of the sternum was anaesthetic and the other not, both of which facts have been denied by others, and are almost certainly incorrect, as the whole bone vibrates wherever the fork is applied. Egger also drew attention to the fact that if the ulnar nerve is damaged at the wrist there is very little loss of sensation, but if the damage is at the elbow, before the branches to the radius and ulna are given off, the loss is much greater. This is sometimes of advantage in diagnosing hysterical anaesthesias. He also noted the decrease in the sensation with age.

Dowgeitschenko (7) noted also this decrease with age, and the fact that a thick layer of soft parts over the bone reduced the sensibility. Reidel and Seiffer (30) worked with a fork of 64 vibrations per second and weighing 100 grams. They used the Gradenigo triangle and compared the two sides of the body. They came to the conclusion that the sensation was a function of deep sensibility and that all the superimposed tissues could take part in it. The sensation might be altered whilst the others were still normal, and be an early sign of ataxia. Sterling (31) used the Gradenigo triangle and stated that the vibration sensation depended on the relative densities of the vibrating body and the tissues that carry the sensation.

Goldscheider (13) maintained the relationship of the sensation with those of pressure and touch, pointing out that vibrations of soft yielding skin were less clear than when the skin was taut. He did not believe the vibratory sensation to be a special one, but a result of a peculiar stimulation of the end organs responsible for pressure and touch.

Knapp (19) worked with six forks, with vibrations from 32 to 2048 per second. He found that a rate of 512 vibrations per second was the greatest rate normally perceptible. This is of interest in that an instrument firm has recently been sending to medical men, in order to advertise its products, a small tuning fork, free of charge. The vibration rate is 512 per second, so many practitioners, if they bother to use the fork at all, will find the vibration sensation of many of their patients incorrectly reduced. Knapp compared the sensation of different parts of the body.

Minor (24) used a tuning fork with the Gradenigo triangle. He enunciated various important facts.

a. The continuity of the bone was not necessary for a normal appreciation of the sensation.

b. The vibrations were felt if the funing fork was applied to a piece of bone bounded by a fracture and a damaged joint.

c. Periostitis, caries and superficial thickenings of bone have no effect on the sensation.

d. The vibrations were felt on bare bones and on sequestra.

e. The vibration sensation was diminished when the peripheral nerves were injured.

All these facts suggested that whilst the bone had an important role in the appreciation of the sensation it was not the site of its reception. Minor also suggested that an electrical contrivance be elaborated whereby the amplitude of a fork may be automatically regulated. Forli and Barrovecchio (11) continued the vogue of the Gradenigo triangle.

Williamson (35) devoted himself to the study of the sensation of vibration, and in a series of papers from 1905 to 1922 has shown himself to be the foremost student of the application of the sensation of vibration to the patient himself. The previous writers were mainly concerned with the scientific and physiological side of the problem,and it was left to Williamson to make the study clinical. A brief resumé of his work follows.

He used an A fork with a vibration rate of 440 per second, rather high according to modern standards. It was $7\frac{1}{2}$ inches long. He stated that the sensation was not conducted in the grey matter of the cord, and did not decussate in it. He declared

a. That the test of the sensation of vibration was useful, as it was often found to be absent before other physical signs of disease could be elicited.

b. Small changes were easily observed.

c. In recovery it was often the last to return.

d. In diseases of the motor systems no change could be found.

e. The test of the sensation was useful in detecting hysteria and malingering, i.e. if only the sensation of vibration was absent and the other sensations were normal it was unlikely to be hysterical.

f. The upper limit of the spinal lesion could sometimes be mapped out by testing the anterior abdominal wall.

Williamson stated that there was no loss in amyotrophic lateral sclerosis, progressive muscular atrophy, primary lateral sclerosis, anterior poliomyelitis, paralysis agitans, pseudohypertrophic paralysis, idiopathic muscular atrophy, neurasthenia, sciatica, primary brachial neuritis and syringomyelia.

It was an early sign in multiple peripheral neuritis, when the knee jerks might still be present with no other concomitant sensory loss. The loss was slight in the neuritis of diabetes mellitus, where the vibration sensation was lost in 18 out of 100 cases. The tuning fork was useful in distinguishing between multiple peripheral neuritis or acute myelitis and anterior poliomyelitis.

In postero-lateral sclerosis the loss was early. In disseminated sclerosis it was often the only sensation that was defective. In tabes there was early loss, also in spinal syphilis, compression myelitis, spinal meningeal

tumours. In cerebral lesions other forms of anaesthesia usually occurred before the loss of vibration. There was often a loss in pernicious anaemia. In a case of anaesthesia of a limb, if the tuning fork cannot be felt vibrating in the anaesthetic area, but can be felt vibrating when applied to the same bone outside the anaesthetic area, the condition is probably hysterical. This applies also to the sternum in hemianaesthesia. He also stated that there was no loss when a peripheral nerve was injured, although there might be loss of other sensations.

His work suffers from the defect that he has not used a quantitative method of measuring the sensation.

Bing (4) carried out experiments to differentiate the sensation from others. He used various anaesthetics, such as carbon dioxide snow, ethyl chloride, and adrenalin with cocaine, and found that after anaesthesia of the skin, the vibratory sensation was slightly, but not markedly diminished. He distinguished the sensation from touch.

Lewandowsky (20) and also Head (17), developed a method of testing the sensation of vibration which might be called the "alternate displacement" or "fatigue" method. The tuning fork is applied to a bone, say the right radius, and when the patient states he can no longer feel the vibration a stop-watch is started and the tuning fork immediately transferred to the radius of the other arm, when the sensation will again be felt. Then time is then taken until the sensation ceases in the left radius. The

tuning fork is then struck again and reapplied, first to the left radius, then to the right. Any marked difference between the two readings was held to be pathological.

There are serious objections to this method which might be dealt with here.

a. The vibration sensibility of the two sides of the body are often different, some writers stating that the sensation on the right, others that the sensation on the left side, is the more acute.

b. When one side is known to be abnormal the normal side cannot be measured against it, and has to be measured against a different limb, i.e. arm against leg. Usually the leg has a smaller sensibility than the arm.

c. No account is taken of the force with which the fork is struck, i.e. its amplitude, for if the fork is started with a large amplitude its vibrations will last longer.

Experiment 1.

Strike the fork so that the amplitude is small, i.e. apply it just when the large window disappears (see later section for method) and test by Head's alternate displacement method, from right radius to left radius. Then do the experiment again, this time striking the fork until it clicks and applying immediately, i.e. when it is at its maximum amplitude. This can be repeated four times.

Results.

Minimum amplitude		Maximum amplitude	
10	seconds	11	seconds
7	"	11	"
10	"	13.5	"
8.5	"	10.5	"
Average 8.9	"	Average 11.5	"

i.e. with Head's method the tuning fork is felt longer if struck harder. Head did not take account quantitatively of the strength with which the fork was struck.

The main conclusions from Head's (17) work deal with the nature of the sensation, and have become generally recognised. The tuning fork stimulates two aspects of sensation.

a. That of "jarring contacts" which are appreciated by the thalamus. (Vibration is perceived but differently, when the thalamus is cut off from the cortex.)

b. That of rapidly repeated movements of small range. These are similar to the perception of passive movements, and are appreciated by the cortex.

Head emphasised the close correlation between the sensation of vibration and the appreciation of measured movement, and believed that the latter was a better test. The impulses conveying recognition of posture, movement and vibration go straight up the cord and have no secondary tracts. Above the thalamus no lesion can cause complete insensibility to vibration, although it may cause diminution, except in epilepsy or neural shock. The sensation of vibration is thus only useful, and perhaps the most

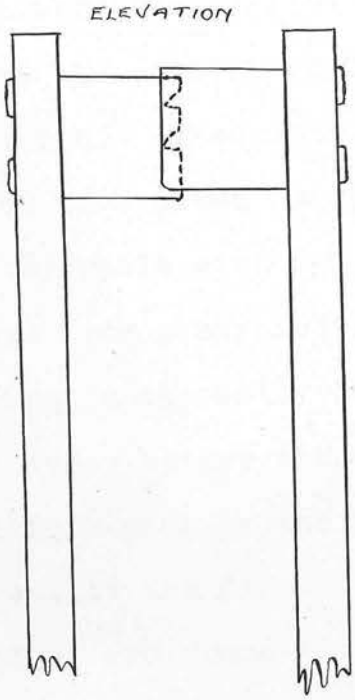
useful as a sign of the integrity of the posterior columns.

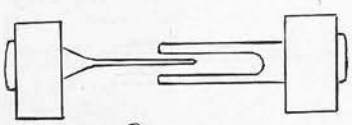
The sensations of passive movement and vibration both depend on a series of minute contacts with both spatial and temporal relationships. In passive movement it is the spatial relationship that is the stressed factor, in vibration the temporal one. Head points out that the organs of the lateral line in fish are to preserve posture, and also to respond to vibrations in the water, hence the two sensations are associated from a developmental point of view. He states that the tuning fork is of little value in testing lesions of peripheral nerves, due to spread of the sensation, but is for that reason useful in hysteria.

A cortical lesion diminishes the"plainness" of the sensation and shortens its duration. When the thalamus is divorced from cortical control the sensation of vibration is sometimes exeessive or painful. This fact is easily demonstrated, and was also remarked upon by Roussy and Epstein.

Symns (32) developed what is undoubtedly the most useful advance in the use of the tuning fork. He used a large A fork, made by Down Bros. with a vibration rate of 108.75 per second. The feature of this fork is the presence between the prong tips of three interlapping plates of metal (see diagram). One of these plates, which fits in between the two plates on the other prong bears two notches, which are invisible, when the fork is at rest, but visible when it is struck fairly hard. The fork is struck, and applied

ELEVATION





PLAN

to the body just when the notch, or window, is about to disappear, and a stop watch is started at the same time. The time is taken when the patient states that he can no longer feel the vibration. This method ensures that the fork is always applied at a given amplitude, and results are quantitatively comparable with results from other parts of the body, and from other individuals. Unfortunately results are not necessarily comparable with different forks, for every worker since Symns, using a presumably identical fork made by the same firm, have agreed that Symns' results are far too high. The firm investigated the matter, and found that the discrepancy was probably due to differences in temper and weight of the prong. To avoid this in future all forks made by that firm are tested against a known normal member of its staff, and his graph is delivered with every new fork. The results can be plotted on a graph which is also sold by Down Bros.

Symns' results showed that in diabetes mellitus with neuritis there was loss of vibratory sensation, but only in the legs. In alcoholic neuritis the legs and arms were always affected, the sacrum sometimes. In plumbic neuritis the legs were commonly, the arms less commonly, involved. He stated that in the above conditions, were we able to measure loss of other sensations as accurately as we do vibration, they might also be found deficient.

In tabes he declared that

a. There was diminution over the lower limbs and sacrum,

b. Occasionally diminution over the arms,

c. Loss was equal over both limbs,

d. There was a correlation between loss of vibration sensibility and deep sensibility, i.e. Rhombergism,

e. There is always a loss of vibration sensibility over the sacrum.

In disseminated sclerosis there was always a loss over the sacrum, and sometimes over the long bones. There was always a loss in the limb affected with sciatica (in contradistinction with Williamson). This loss I have been unable to confirm.

There was no loss in amyotrophic lateral sclerosis, paralysis agitans, and progressive muscular atrophy.

Symns makes certain statements regarding the value of the tuning fork. They are -

a. When vibration sensation over the sacrum is absent the cord is affected.

b. When present over the sacrum but absent over one or other extremity the condition is a peripheral neuritis.

c. If loss is general there is a systemic poisoning.

d. If unilateral the cord is affected.

As regards the nature of the sensation Symns mentions the work of Minor and remarks that joints are not concerned in the production of the sensation, continuity of bone is not necessary, and that injury of nerves produces a loss. He concludes from this that the stimulus is carried through the skin and soft parts, and transmitted along the bones, but is felt in the soft tissues. A small tuning fork may not be felt over anaesthetised skin, when a larger one will be, i.e. both light touch and deep pressure are involved.

Wood (37) continued Symns' work in the same school. Whereas Symns had only used thirty cases to establish a normal, Wood used a hundred, and got a series of curves which are the basis of the published charts. He demonstrated that Symns' curves were far too high, probably due to the temper and weight of the fork he used. He found the same sacral dip in tabetics that was emphasised by Symns. He remarked on the frequency with which cases, being treated as gastric and duodenal ulcers, were later shown to be tabetics with gastric crises, as a result of routine testing with the tuning fork, followed up by examination of the cerebro-spinal fluid. Friedreich's ataxias showed a tabetic graph.

Piercy (27) remarks on the advance made by the Symns fork with which a delicate quantitative test may be done. By testing the sensation qualitatively small changes are certain to be missed, and a record of the sensation to

show improvement or remission cannot be obtained. He found little or no change in brachial or sciatic neuritis, even though the Achilles jerk was lost. He emphatically agrees with Symns and Wood with regard to their definition of a typical tabetic graph, and insists on the importance of the sacral dip, even when the fork is used as a routine in gastric cases. He does not suggest however that this dip is diagnostic of tabes, but it should be confirmed by an examination of the cerebro-spinal fluid. The only exception to the tabetic curve in tabes, in Piercy's experience,was in three cases, which curiously enough, all had pulmonary tuberculosis. In most cases of syphilis confined to the upper motor neurone no marked changes could be found, as would be expected, the vibratory test being a sign of the integrity of the posterior columns. "The vibratory sense is the last to disappear and the first to return in disease of the brain, whereas in disease of the cord it is usually the first to be disturbed and the last to return."

Depression or absence in the lower extremity and pelvis was common in chronic alcoholism. In old age there tended to be a diminution over the sacrum which Piercy agrees was probably due to arteriosclerosis. He found no change in syringo-myelia.

Ahrens (2) repeated the work of Symns and Wood, and verified the latter. He also worked out a series of a hundred normal curves and found that his normal graph was

slightly wider than Wood's, although from 72% to 96% of all his normal readings fell in Wood's normal. All three graphs are illustrated on page ii . Ahrens emphasised the fact that much depended on the intelligence of the patient, his state of mind, fatigue and extraneous distractions.

Amongst his observations are

a. The sensation in the majority is higher in the arms than in the lower limbs,

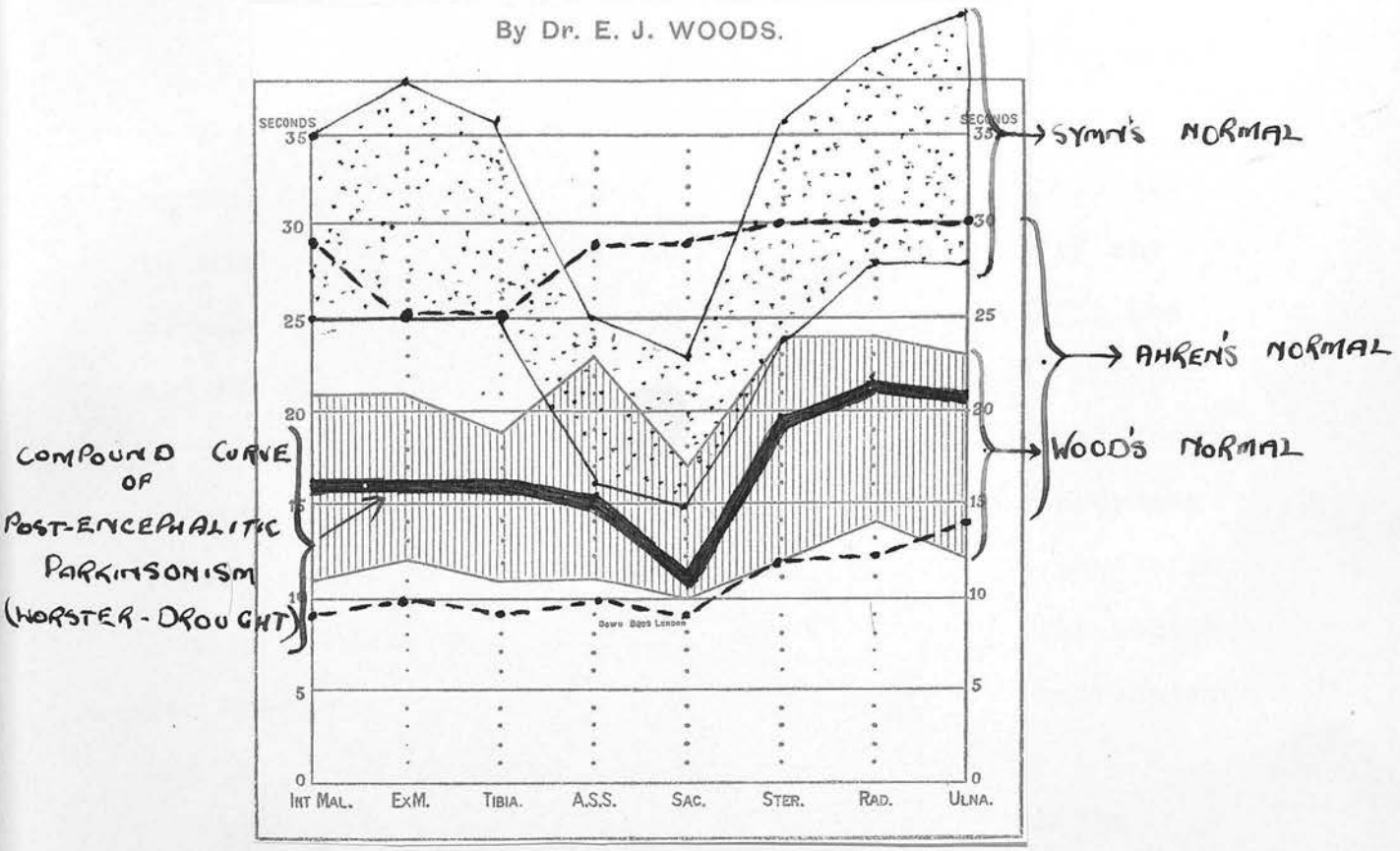
b. In only fifteen out of a hundred is the sternum more sensitive than the ulna or radius.

c. Nearly always the sensation is felt longer on one side than on the other, neither side predominating on the anterior superior spine and lower limbs, but the right side predominating in the arm.

d. 68% show decreased sensitivity over the sternum.

He tested a number of patients with pernicious anaemia, and stated that no patient had a normal sensation of vibration, none had impairment of upper extremities alone, and that none had complete loss in both hands and feet. The curves did not vary in the exacerbations and remissions of the disease. Four cases had a tabetic type of curve.

Most cases of G.P.I. had tabetic curves (strongly denied by Piercy), two were normal. Four with post-encephalitic parkinsonism were normal, five with transverse myelitis showed complete absence of the sensation of vibration.


By Dr. E. J. WOODS.
SECONDS
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A.S.S.
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ULNA.
SYMM'S NORMAL
AHREN'S NORMAL
WOOD'S NORMAL
COMPOUND CURVE OF POST-ENCEPHALITIC PARKINSONISM (WORSTER-DROUGHT)

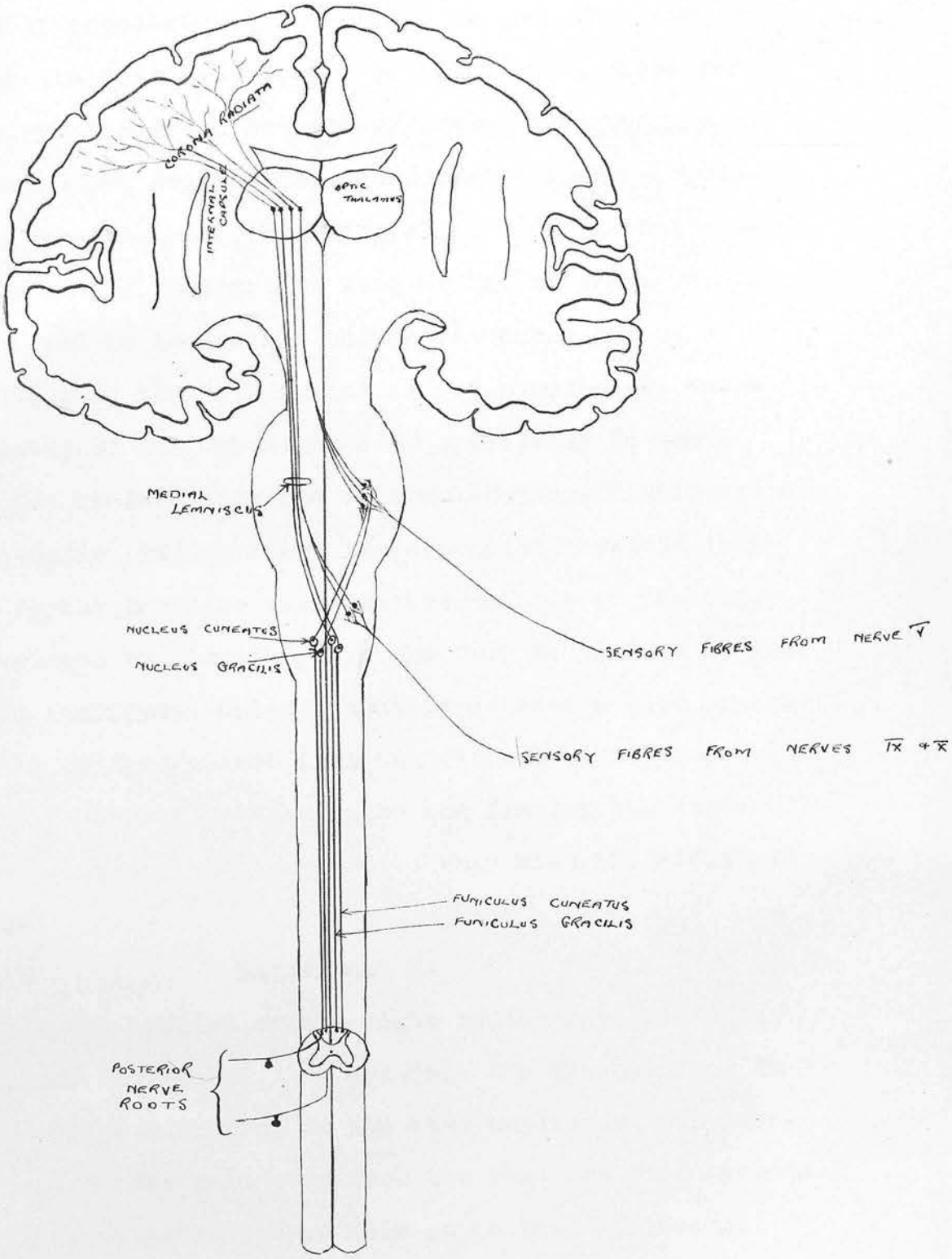
Diabetics often showed a peripheral neuritis when examined with the tuning fork.

Friedmam (12) in a study of subacute combined degeneration of the cord emphasises the importance of testing the sensation of vibration, which he states is usually the first to disappear.

Epstein (9) describes the route in the cord and brain that the nervous impulse takes. The neurones of the first order travel in the columns of Goll and Burdach and end in the nuclei gracilis and cuneatus. Neurones of the second order relayed from these nuclei decussate as the median lemniscus, and end in the optic thalamus, which is the subcortical station subserving primitive undifferentiated sensation. Thalamo-cortical paths of neurones (third order) traverse the posterior end of the posterior limb of the internal capsule, pass into the corona radiata and end in the sensory cortex, which organises and analyses the perceptions. (See diagram on page iii.).

Epstein insists on comparing each point with its homologue on the other side. He uses an ordinary fork, strikes it vigorously until it clicks. He says that whilst timing with a stop watch there need be no special hurry to place the fork on the point selected, but there should be no undue pressure.

He emphasises the use of the fork in multiple neuritis, i.e. of lead, arsenic etc., its use in hysteria, in diagnosing pure affections of the motor systems, such as progressive muscular atrophy. He agrees with the picture



ADAPTED FROM EPSTEIN

of tabes presented by Symns. Epstein describes Head's method of complementary displacement, but does not mention its disadvantages. He states that there are changes in the Brown Sequard syndrome, cord tumours, intramedullary degenerative conditions, such as syringomyelia, myelomalacia, haematomyelia. Occasionally in lesions of the thalamus an exaggerated response is obtained, and in lesions of the cortex there may be a diminution of the "plainness" of the perception, and a shortening of its duration, seen especially in the phalanges by Head's method of complementary displacement.

McKinley (22) mentions the essential physiological error in the previous quantitative methods of testing, as developed by Symns. Here the fork is applied at its maximum amplitude, which gradually decreases to a minimum, when the patient cannot feel the vibrations any more; instead of beginning from below and finding the threshold. I have devised a short method to show also the effect of fatigue.

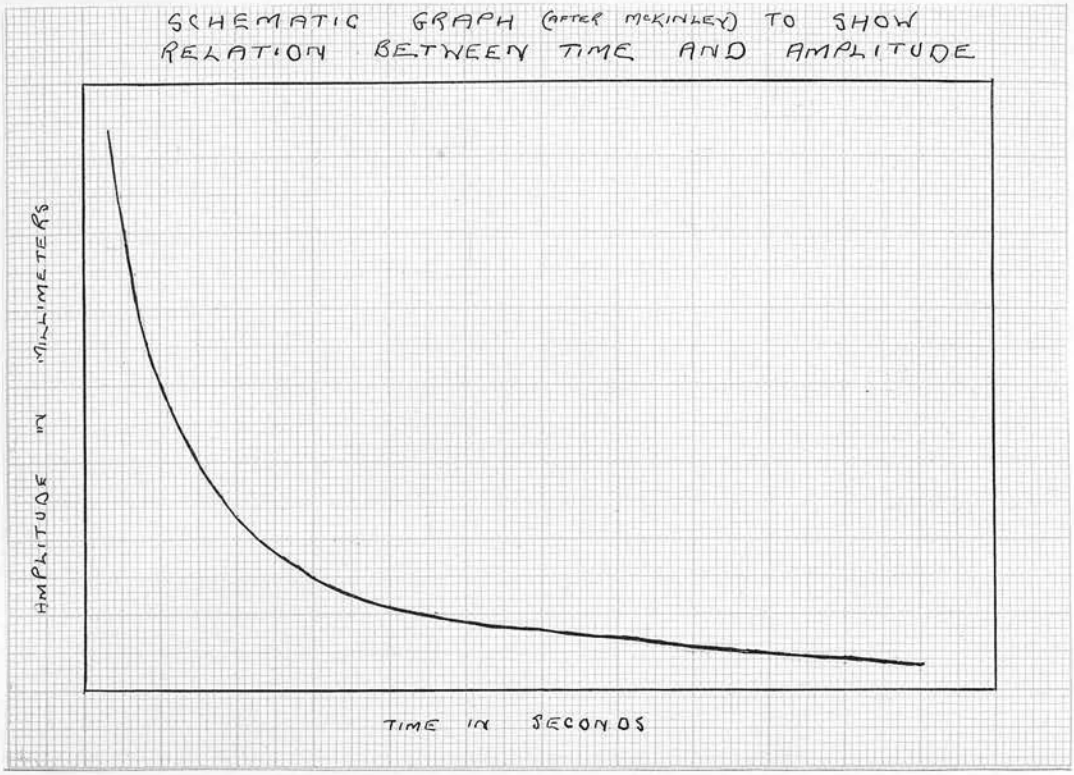
Experiment 2.

The fork was applied to the right radius when vibrating at a known amplitude. It was felt for 23 seconds. It was reapplied vibrating at the same amplitude, but every five seconds was held away from the bone for five seconds rest. Its vibrations were felt up to the 32nd second. This shows that the patient ceases to feel the vibration long before the amplitude of the fork has fallen to its

threshold,his senses being dulled by fatigue, so we have been measuring two factors, threshold of amplitude and fatigue.

To obviate this McKinley developed a method of applying the fork at its minimum amplitude. He used a fork of a vibration rate of 128 per second, and weight 501 grams. In order to ensure that it was always applied with the same pressure a metal collar was fitted around the handle, and could slide freely up and down it. The fork was held by this collar, and vertically, so that its pressure was always its own weight.

Between the prong tips could be applied one of a series of rods, of which he had fifteen, of lengths varying between 13.9 mm. and 19 min. to an error of $\pm$ .01 mm. The rod was withdrawn sharply and the fork vibrated at an amplitude depending on the length of the rod. This method is much inferior to that devised by Gray, and not nearly so valuable clinically as the method of Symns. McKinley stated that the rod must be withdrawn at right angles, by a piece of string. Temperature changes are unimportant. The graph of time plotted against amplitude shows that the fork runs down very rapidly at first.



Pearson (26) mentions the neglect of the age factor by other authors, except Egger (8), Rydel and Seiffer (30) and Piercy (27). He used a fork of vibration rate of 128 per second, and states that results are only comparable with the same observer using the same fork. He did not however used Symns' quantitative method with a Down Bros. fork. He stated that the sensation of vibration was best perceived by adolescents, and that there was a diminution decade by decade in the legs, but no diminution in the arms for the first fifty years. In the seventh and eighth decades there is a diminution all over. A similar decrease was stated to occur in parkinsonism, by which the author presumably means that type occurring in old age. To explain this decrease with age he mentions

the work of Williamson (35h) who many years ago, described the vessels of the cord. The vessels of the lumbar cord are less numerous than those of other portions, and arise from spinal arteries that are the longest vessels in the body. The reinforcing vessels must pass upwards in the lower part of the cord. Arterial changes are thus common in these vessels in old people, giving rise to degeneration of the posterior columns, hence to changes in the sensation of vibration.

Gray (15) reasoning from the same objections as McKinley, has developed the most scientific method of testing the sensation of vibration. He uses a fork 35.9 cms. long, with 120 vibrations per second. A magnetic coil is set in between the prongs and the desired amplitude set up by varying the amperage of current running through the apparatus. His work was confined to thirty-four normal cases and a series of cases of pernicious anaemia. The greatest constant amplitude felt by normal persons was 2.34 mms. His general conclusions formed after testing thirty cases of pernicious anaemia were,

a. Younger people have lower vibration thresholds than older people.

b. There is a considerable spread in the thresholds over all points tested, both in normal and pernicious anaemia cases.

c. In general vibratory acuity was reduced in pernicious anaemia.

d. Many normal patients have thresholds above 2.34 mms.

e. More pernicious anaemia cases with than without subacute combined degeneration of the cord have thresholds above 2.34 mms.

f. The sensation on the left side of the body is more acute than that on the right.

He did not find that sacral deficiency was diagnostic of tabes, but only carefully going through the literature I cannot find that anybody said it was, but Symns, Wood, Ahrens and others have declared that it was suggestive and typical of tabes.

The difference between the normal and pernicious anaemia thresholds in the upper extremity and sternum were not great enough for diagnosis. On the anterior superior spines the thresholds were very irregular with a large spread in the normals. On the posterior aspect of the thighs the amplitude was very high, and similarly on the sacrum. (Note, the smaller the amplitude felt the greater the acuity).

Gray noted the tendency to diminution of acuity with age marked on the anterior superior spines and the seventh cervical vertebra. The results on the other vertebrae were too irregular.

There was very little scattering over the tibia and fibula, where there were pronounced differences from the normal both in pernicious anaemia and old age.

Thresholds were greatest on the back, least on the upper extremities, and on the lower extremities occupied an intermediate position. The average normal thresholds, on all points tested, were less than in pernicious anaemia.

Gray made an intensive study of a normal individual on the tibia and found that the threshold improved after repeated testing, i.e. the threshold value on one point on the 12th of June, 1929 was 0.22 mms., and on the same point on the 2nd of April 1930 was 0.018 mms. On another point it was 0.549 mms., and 0.031 mms. on the same two dates.

Gray notes that overtones in his instrument persisted for thirty seconds. He believes that the bone is the site of reception of the sensation. Twenty out of thirty of his cases of pernicious anaemia showed cord involvement. My criticism of Gray's method is that, although it is scientifically accurate it is

a. Far too cumbersome and lengthy for routine clinical use.

b. His thresholds for one point have a much larger spread than the equivalent threshold-fatigue time method of Symns.

c. His method shows nothing clinically that cannot be shown by the Symns fork.

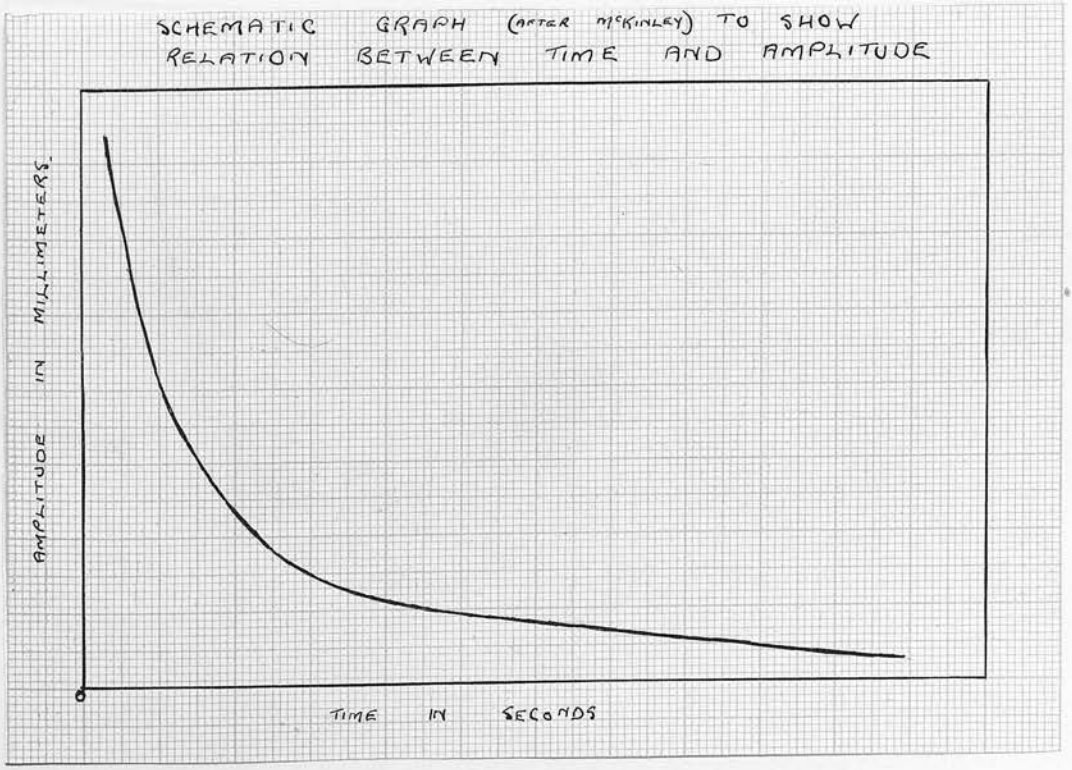
d. If it is insisted that the threshold be approached from below, and not from above, as in Symns' method, and the element of fatigue be eliminated, there can be devised a method of using the Symns fork which fulfils these criteria, and which is no more involved.

An original method of testing the sensation of vibration.

The ideal method of testing the sensation of vibration should 1. Approach the threshold from below, 2. Should give the result in millimeters of amplitude of the fork, 3. Should not be so cumbersome that it cannot be used in routine examinations. 4. The factor of fatigue should be eliminated.

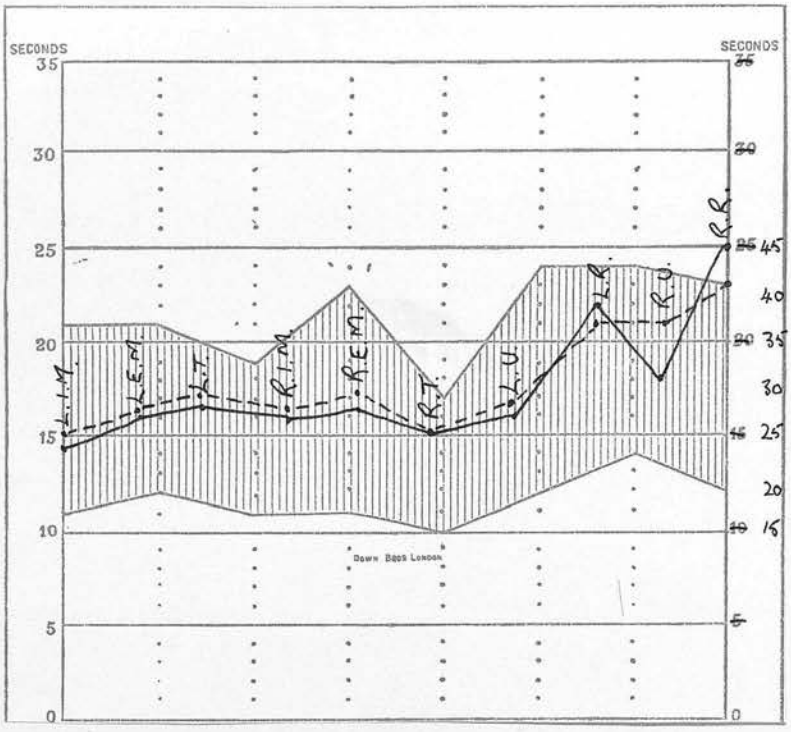
Symns' method does not fulfil 1, 2 and 4, Gray's and McKinley's method No. 3.

If the Symns fork be struck and the stop-watch started at a known amplitude, i.e. when the first window disappears, the amplitude decreases, with a decreasing rate which can be plotted against the time.



The fork is kept vibrating, for, say 30 seconds, and then, and not until then, applied to the bone. The patient is asked to state whether he can feel the vibration or not. If he can, the process is repeated, increasing the length of time that the fork is held away from the bone, until a time is reached when the vibrations cannot be felt. The previous reading is the threshold value for that bone. Similarly if at first the vibrations cannot be felt, the time is reduced until they can be. In practice, as the amplitude decreases with the time, it is not necessary to change the latter units into the former, especially as complicated apparatus is required to plot the required graph, which would vary with each fork. In the present instance the apparatus was not procurable. Three and not more than four applications are necessary to find each threshold, and may be reduced to two. For the experiment here recorded the time intervals are advanced or decreased with time intervals of 2.5 seconds.

Two graphs of a normal individual are compared (See page IV). The continuous line is the threshold-fatigue curve of Symns, the dotted line the minimum threshold method, as it might be termed. A striking correlation is seen between the two graphs, which speaks much for the accuracy of both methods. A disadvantage, which is easily rectified, is the length of time one has to wait for each application, i.e. 25 to 40 seconds. This is because the fork is made to be applied at a



STRAIGHT LINE = CURVE ACCORDING TO SYMNS' TIME-FATIGUE METHOD. (TIME ON LEFT)

INTERRUPTED LINE = CURVE ACCORDING TO MINIMUM-THRESHOLD METHOD (TIME ON RIGHT)

relatively high amplitude. If it were applied at a lower amplitude the delay would be much less. To lower the amplitude it would only be necessary to have a larger window made in the metal slot.

A great advantage of the method is the clear-cut yes or no.reply required from the patient, who either feels the vibration or does not, much different from the hesitant replies often obtained from the most intelligent patients in the method of Symns, when he or she has to say when a slowly disappearing sensation becomes imperceptable.

The results were

	Minimum threshold.	Symns' method.
Right Radius	40 seconds.	25 seconds.
Right ulna	37.5 "	18 "
Left radius	37.5 "	22 "
Left ulna	27.5 "	16 "
Right Tibia	25 "	15 "
Right ext. malleolus	30. "	16.5 "
Right int. malleolus	27.5 "	16 "
Left tibia	30 "	17 "
Left ext. malleolus	27.5 "	16 "
Left int. malleolus	25 "	14 "

In the case of, say, the right radius, the vibrations are only felt for 25 seconds, starting from a given amplitude, if the fork is continuously kept applied to the bone. The

threshold value for the sensation is, however, only reached after 40 seconds. The difference, 15 seconds, is loss due to fatigue, and perhaps to a slight extent inability to appreciate a correct end point when the threshold is approached from above. These numbers cannot unfo-rtunately be used as proportions or fractions of one another, i.e. we cannot say that $\frac{15}{40}$ths or $\frac{3}{8}$ths of the sensation ~~is~~ are lost due to fatigue, because the time in seconds only represents a definite amplitude and does not vary directly with it, for the amplitude grows less at a slower rate with each second. To find the mathematical relationships the correlation between time and amplitude would have to be worked out, which unfortunately in this case was not possible.

The Nature of the Sensation.

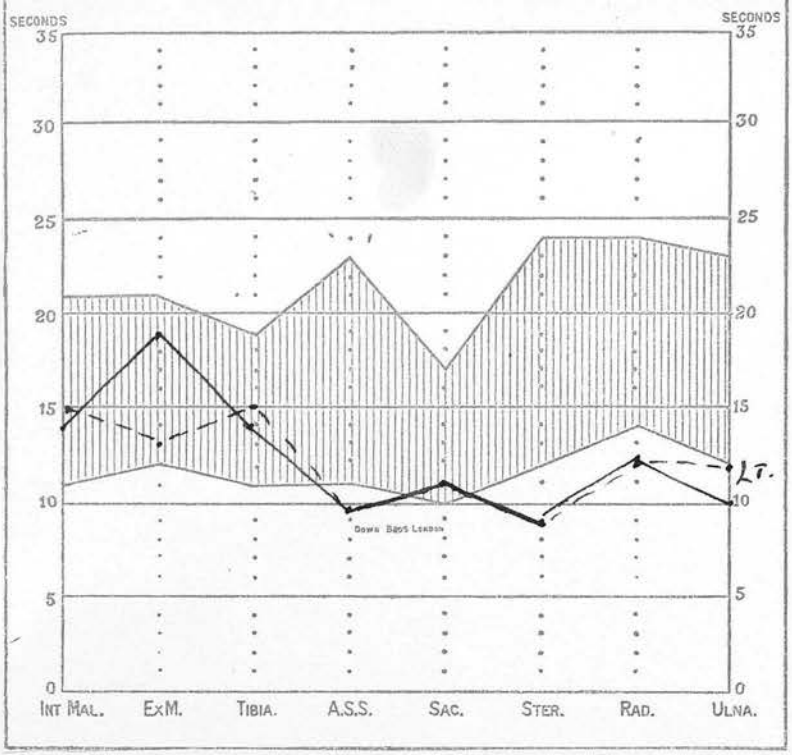
There is unanimity among the workers as to the route taken by the nervous impulse in the nervous system, and this was described in the previous section. Disagreement arises in the study of the site of the reception of the stimulus.

Rumpf (29) believed that the sensation was confined to the skin. Treitel (34) thought it was distinct from both pressure and touch as opposed to Goldscheider (13), who maintained this relationship. Egger (8) was the first to put forward the idea that the end-organs of the sensation lay in the bone, periosteum, ligaments and capsules of the bones and joints. Minor (24) in a reasoned paper showed that continuity of the bone was not necessary for perfect reception of the stimulus, that periostitis, caries and superficial thickenings of the bone had little effect, and that the sensation could be felt on a dead sequestrum. All this pointed to the fact that the bone was probably not the site of reception. It is rather disconcerting when unaware of the fact, and first applying the fork to a small fragment of bone, to find that the sensation there is as good as that in the normal limb.

Bing (4) differentiated the sensation from that of touch by excluding the latter with local anaesthesia. Head (17) analysed the subjective sensation into the two factors of "jarring contacts" appreciated by the thalamus, and rapidly repeated movements of small range, perceived

by the cerebral cortex. He noted the close relationship between the sensation of vibration and those of passive movement and posture. Symns (32) stressed the same relationship, noting the correlation in tabes between Rhombergism and absence of the sensation of vibration at the sacrum. Tilney (33) believes that the sensation arises in the bone and thinks pallaesthesia is a suitable term for the sensation. Epstein (9) and Gray (15) have the same opinion.

It is worth mentioning a few facts. If a small tuning fork, of 512 vibrations per second, is applied to the skin it will be found that the sensation can be abolished by local anaesthsia. This cannot be done when using Symns' large tuning fork, which can certainly be felt on the skin, but neither as long there, nor so clearly as when applied to the bone. Disease and injury of bone, however, have very little effect on the duration and distinctness of the reception of the stimulus. Three examples are cited. In one, where the affected femur was the site of extensive chondromatosis (see X-Ray) the sensation in (p. v, vi) it was higher than in the normal limb. In another there was decalcification with a suggestion of fibrocystic disease in the right radius (see X-Ray), and no appreci- (p vii, viii) able difference in the vibratory sensation. In a third, the patient had had an ankylosed left knee, resulting from tuberculosis in early youth, and the affected limb, due to disuse atrophy, was considerably shorter than the normal.

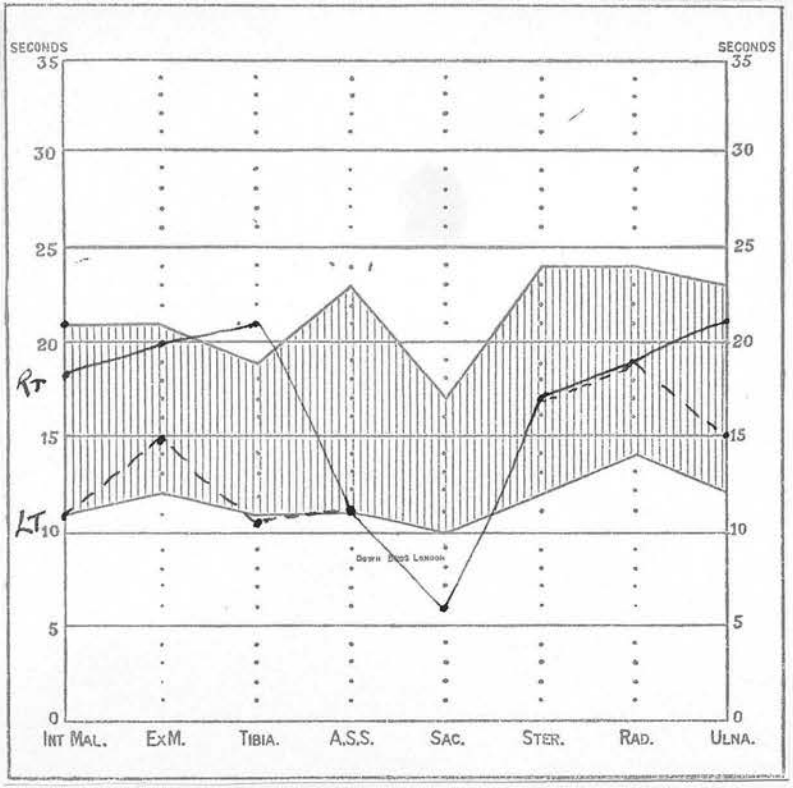


Bony Changes.

Lawrence Whiteley (28)
24, Catherine Street,
Elland.

Multiple chondromata.

LAWRENCE WHITELEY



Bony changes.

William Hoyle (53)
Rashcliffe Hill Road, Huddersfield.

Pain in left forearm, X-rayed. Pain in right shoulder, periodically. Pain in left side chest.

Four years ago fell from roof, broke humerus. Five months later, and in July, 1934 broke same bone.

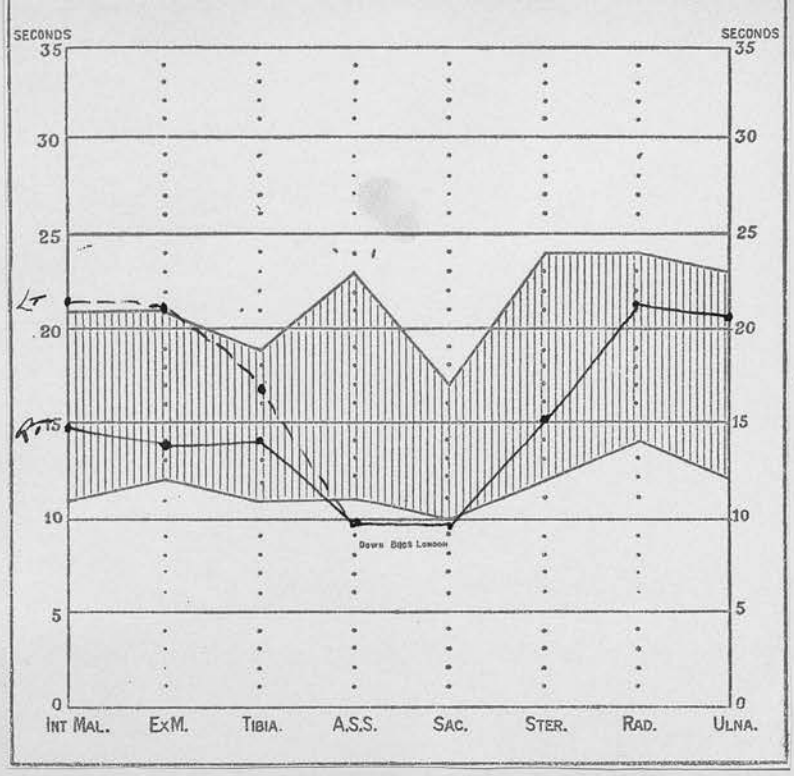
X-Ray. Head of humerus shows healed osteomyelitis or old cystic disease.

Serum phosphorus = 3.9 mgs %
Serum calcium = 9.5 mgs %

No tumour in neck.

Second X-Ray - Left forearm suggestive of "osteitis fibrosa cystica"

WILLIAM HOYLE



Bony changes.

Martha Earnshaw
34, Longwood Road,
Paddock.

Old tuberculous left knee joint, with marked shortening and contracture.

Aet 2-3.

Vaso - vagal syndrome

Some Interesting Features.

Fatigue.

The sensation of vibration is dulled by fatigue. Of this there are two forms, which may be termed intrinsic (a distinction apparently not hitherto drawn) and extrinsic fatigue[4]. Intrinsic fatigue is the diminution of the acuity at the point tested due to the continued application of the fork. This has been dealt with earlier. Extrinsic fatigue is due to fatigue of the organism as a whole.

Experiment 4.

To demonstrate this a round of 18 holes of golf was played, and the sensation examined both before and after. The results showed a considerable diminution in the sensation.

	Before	After
Right radius	22 seconds	16 seconds
Right ulna	22 "	16 "
Left radius	22 "	17 "
Left ulna	19 "	16 "

The extrinsic fatigue had also the effect of increasing the intrinsic fatigue, for a minute or two after testing the right radius it was tested again, and found to have dropped to 10.5, an event that does not happen in an untired individual.

Use in fractures.

If the tuning fork be applied to a broken bone and the vibration listened for with a stethoscope on the other side of the fracture a humming will be heard which is not as acute as if the stethoscope were held on the same side of the fracture as the tuning fork. In this way the site of fracture may be more or less located, making allowances for impaction of the ends. In view of the far more accurate modern method of X-Rays it has not been considered worth while developing this subject further.

In Chest Diseases.

If the handle of the vibrating tuning fork be held in the mouth, and the chest auscultated the vibrations can be heard over the chest wall, and vary just as when vocal resonance is auscultated. Again it is difficult to find any superiority of this method over the old one of vocal resonance, which is much simpler, except perhaps in the dumb.

Effect of Pressure.

The question arises as to the effect of the pressure with which the tuning fork is applied to the point tested. Various workers have developed a sliding collar to fit on the handle, thus ensuring that the pressure shall always be uniform.

Experiment 5.

The fork was first applied with normal pressure, then with very heavy pressure and finally lightly. The results were

	Normal pressure	Heavy	Light
Right radius	25 seconds	16 seconds	18.5 seconds
Right ulna	19 "	15 "	18.5 "
Left radius	22 "	14 "	16 "
Left ulna	16 "	15.5 "	17 "

The results show a considerable diminution in the acuity of the sensation if the fork be applied with great pressure. This is due mainly to the damping down of the vibratory capabilities of the bone by the force with which the fork is applied, and partially to the discomfort that the patient experiences. With very light pressure the sensation is also diminished, but not to the extent it is when heavy pressure is applied. With experience the fork can be applied with a steady medium pressure and results are uniform. Special apparatus is not necessary.

Vocal Fremitus.

Various workers have remarked on the difference in vibratory acuity of the two sides of the body. Some have stated the sensation on the left side to be the more acute, others that on the right. In this study the difference was noted, but no special side was found to predominate. This proves the clinical importance of testing vocal fremitus with the same hand each time.

CLINICAL APPLICATION

A series of 100 pathological cases is presented in this thesis, together with ten cases, not suffering from nervous lesions, to act as controls. The 100 pathological cases consist of

Diabetes	25
Pernicious Anaemia	25
Blind individuals	5
Post-encephalitic Parkinsonism	5
Tabes Dorsalis	5
Disseminated Sclerosis	5
Syphilitic Aortitis	5
Microcytic Anaemia	5
Old Age	5
Miscellaneous	15

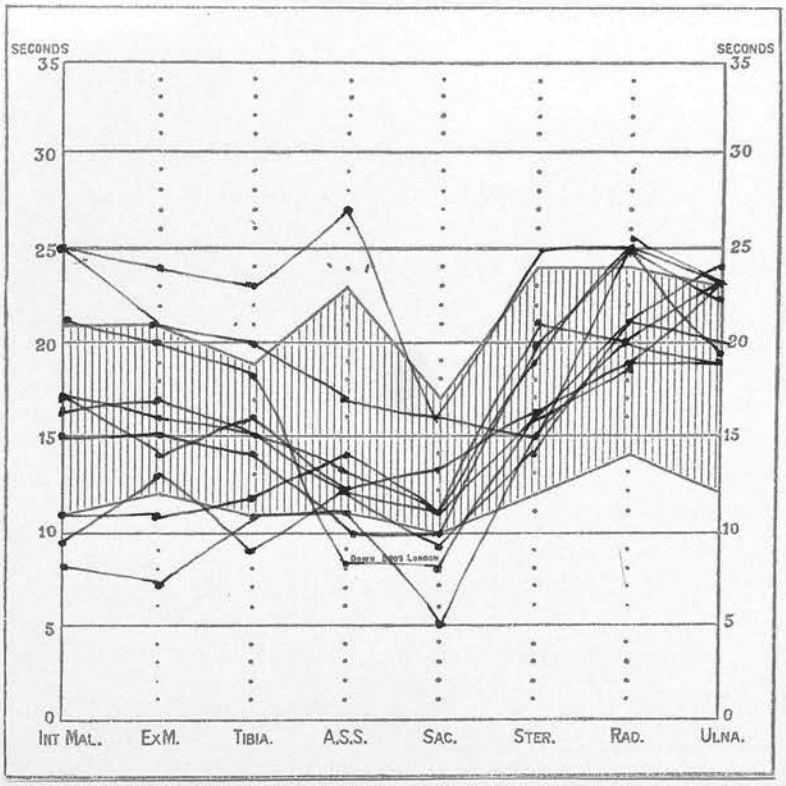
All attended the Royal Infirmary, Huddersfield, either as in-patients or out-patients, except the blind individuals, who were all active, healthy, and trained workers. The blind individuals were examined by the courtesy of the Huddersfield Blind Society.

The technique adopted was that developed by Symns.(32) The fork used is a large A fork, of 108.5 vibrations per second, and prongs just under $9\frac{1}{2}$ inches long. It is made by Down Bros., and each fork supplied is tested against a normal individual in their employ, and the graph sent along with the fork.

The fork is struck, and when the first window just disappears a stop-watch is started, and the handle of the fork applied to the point to be examined. The patient should be at ease, not tired, and should, before beginning the real test, be made to understand just what he has to do. During the testing the patient can be examined as to his reliability by applying the fork when the vibrations have been stopped. When the patient ceases to feel the sensation he says "yes," and the watch is stopped. With a reasonably intelligent subject successive tests show considerable accuracy, and need not vary more than 10% on repeated testing. The points tested are the radius and ulna, sternum, sacrum, anterior superior spines, tibia, internal and external malleoli. Both sides are tested, and if there is any appreciable difference the two results are recorded on the same graph. The fork should be applied with a constant pressure, firm, but not heavy, care being taken not to hurt the patient. Leading questions should of course be avoided.

The ten cases used as controls were not intended to set a standard of normality but merely to check the tuning-fork with the comprehensive series of normals already investigated by Wood[37] and Ahrens.[2] They include a case of embolic streptococcal nephritis, one of debility, one of neurasthenia, one of mitral stenosis, one of gonococcal arthritis, one of hysteria, two of hyperthyroidism

TEN NORMAL CASES



and two of Sydenham's chorea. The latter two are included, although diseases of the central nervous system, as sensory changes are notably absent.

The spread of the curves is certainly wider than Wood described as normal, but except for one case, Edwin Parkin, (xxxix) fits in with that described as normal by Ahrens. This exception was a neurasthenic, and perhaps should not have been included in the series, were it not intended to show that caution should be maintained in estimating the limits of normality, as pure neurasthenics have no derangement of the sensation of vibration. The diminution was slight, was at the sacrum and malleoli, and might possibly have been due to the general loss of tone common in neurasthenic states.

The compound graph shows clearly a feature that has been described by others, the tendency for the vibration sensation in the arms to be fairly high, and approximate closely in different individuals, whereas the spread over the limbs is much wider.

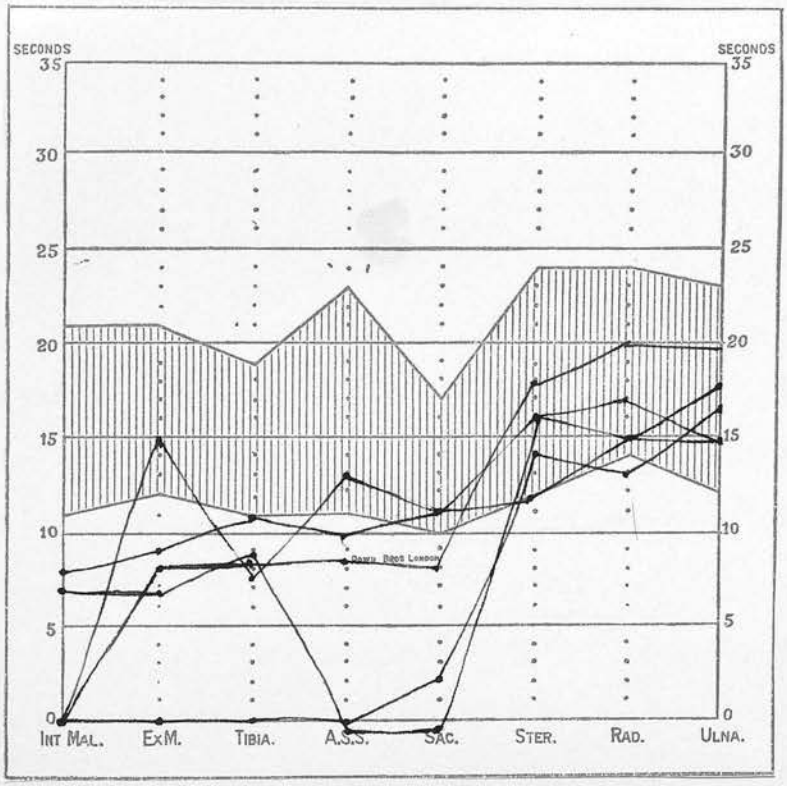
Loss with Age.

The gradual loss of the sensation of vibration has been remarked upon by Egger,[9] Rydel and Seiffer,[37] Piercy,[27] Pearson[26] and Gray.[15] Pearson made the most complete study of it, and stated that in the legs there was a diminution decade by decade, but no change in the arms occurred until the fiftieth year. Gray noted the effect of age on the vertebrae and pelvis, where there was also a loss. The cases examined included two in hospital suffering from fracture of the neck of the femur, one with eczema, one with cholecystitis and one with cataract. The compound graph shows a general tendency to lowering of the threshold. Of the individuals concerned one has a low normal graph, although the patient was aged 77. (P. XLII) All the others were distinctly abnormal, one having complete absence of sensation in the pelvis, the others showing diminution or absence in one or both of the lower limbs. The sensation in the arms fell within the normal in all cases, but was on the low side. The loss, as explained before, is most likely the result of arteriosclerosis of the spinal vessels.

With the tuning fork made by Down Bros. a graph of one of their employees used as a control, is sent. One hopes that the firm realises that as this employee ages, his vibratory acuity will diminish.

OLD AGE

5 CASES



Sensation in the Blind.

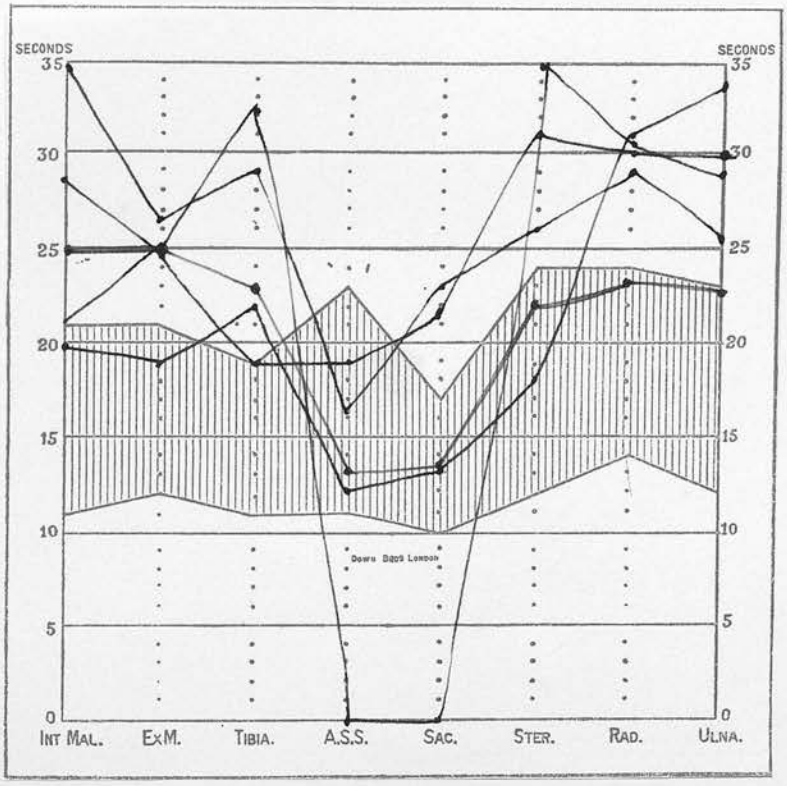
There does not appear to have been any work done on the sensation of vibration in the blind. It is often loosely stated that the sensation of blind individuals is increased, without either adequate quantitative proof, or evidence that the apparent increase is not due to a raising of the threshold for the sensation, but to a better discrimination of what is felt. The sensation of vibration is a useful test for this problem, as it can be quantitatively measured, and it is unlikely that the individual tested can have had much previous experience of the sensation, resulting in better discrimination.

Results show a considerable increase in the vibratory acuity in the blind. Two of the cases, Thomas Clark and (P. xlvii) Winifred Dyson, have what might be termed high normal (P. xlviii) curves. Two of the others, Turner and Wisdom, have (P. l, li) curves that are distinctly above the normal, whilst the fifth, Lucy Poppleton, is curious in that she has very (P. xlix) high acuity in the limbs, but vibratory sensibility is practically absent in the pelvis. On the whole in the five cases the increase tends to be in the limbs and not in the pelvis. There is very little difference between the upper and lower extremities.

It should be noted that all the individuals selected were between the ages of 21 and 41, healthy, and had

been blind for more than ten years, and were trained workers. No cases were included in which the blindness might have been due to lesions of the central nervous system. As it is extremely unlikely that the individuals had trained themselves specifically in the discrimination of vibration one must conclude that the increased acuity is the result of the training of sensation generally. Gray notes that the normal individual in whom he tested the sensation of vibration over a period of months showed a marked increase of acuity with practice. Apparently the same holds true if all sensations are trained generally at the same time.

BLIND INDIVIDUALS
5 CASES



Syphilitic Aortitis.

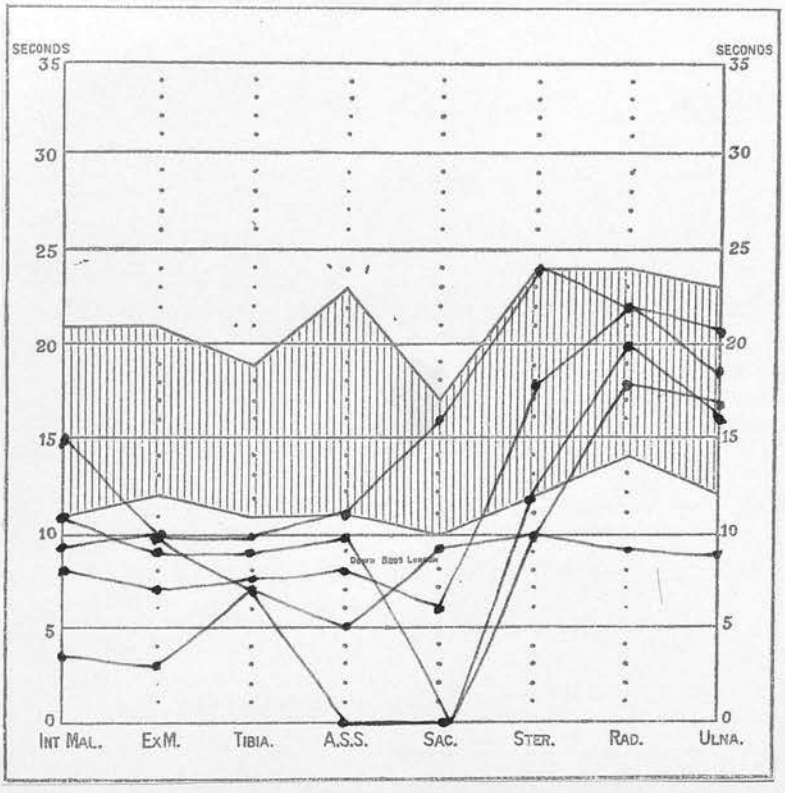
This series of cases was examined to test Symns'[32] assertion that absence of the sensation of vibration at the sacrum denoted a lesion of the central nervous system; the lesion in this case being easily demonstrated by the examination of the cerebro-spinal fluid. None of the patients showed obvious signs of a lesion of the central nervous system.

The first impression from the compound graph is a lessening of the sensation in the pelvis and lower limbs. This general diminution is probably due to the average age of the group, which is 56. The only patient below the age of 52, had the only normal curve. Two cases (p. Liii) had absent vibratory sensation at the sacrum. The cerebro-spinal fluid of one was normal, that of the other showed the following: (p. Lvi)

W.B.C.s = 50 per cmm.
Globulin = excess.
Albumen = 0.05%
Fehlings = reduced.
Colloidal Gold Test = 111210000000.

This shows that absence of sensation of vibration at the sacrum cannot be taken as diagnostic of cord involvement, but it is suggestive, and might be used as a method of weeding out patients. Piercy[24] suggests that absence of sensation of vibration at the sacrum in a patient in whom no cord lesion can be found is suggestive of a healed lesion. This would be difficult to prove.

SYPHILITIC AORTITIS
5 CASES



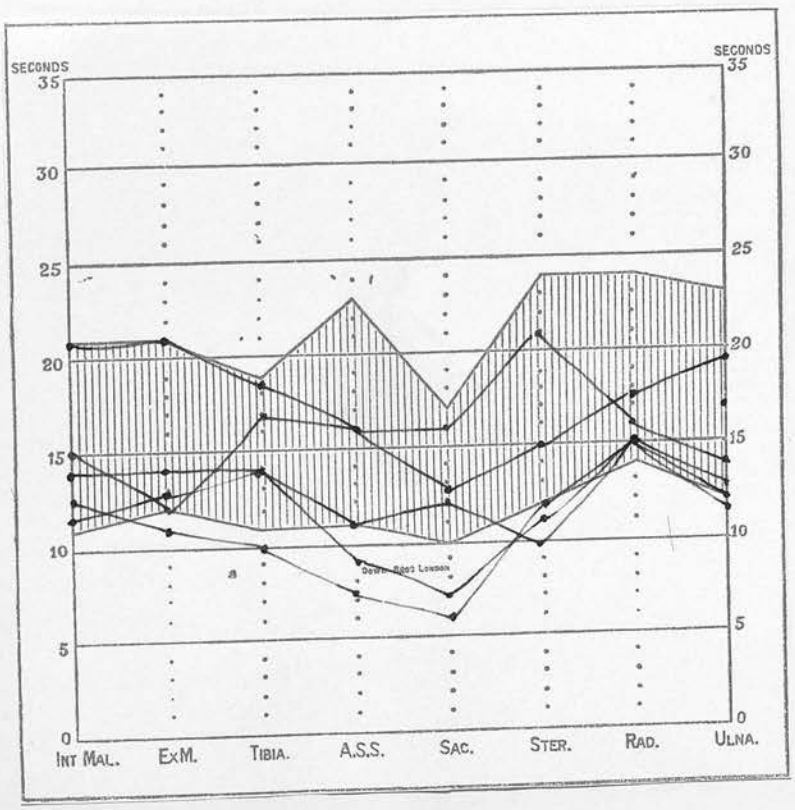
Post-encephalitic Parkinsonism.

In this condition both Williamson[35] and Symns[32] state that there is no change in the acuity of the sensation. This is of course the accepted view, as no change in sensation is usually described.

Worster-Drought and Hill,[38] however, come to a different conclusion, stating that there is a loss, which is worse with the severer forms of the disease, and the sensation is relatively diminished on the more affected side. It appears, however, that although they used Symns' technique, they also accepted what Symns described as the normal. Since it has since been amply proven that Symns' results were too high, due to mechanical features of the fork he used, their conclusions cannot be accepted. They give the mean graph from their cases in their paper, and it is seen that this falls entirely within the normal as described by Wood and Ahrens (See graph page *ii*).

The compound graph of the cases done for this thesis demonstrates that the curves are mostly in the low normal zone. The two individuals whose readings at the sacrum fall rather low are aged 42 and 46. The average age for the group is 40. The feature of each individual curve, as seen in this group, is its evenness, i.e. the readings at different parts of the body do not vary greatly from one another.

POST-ENCEPHALITIC PARKINSONISM
5 CASES



Tabes.

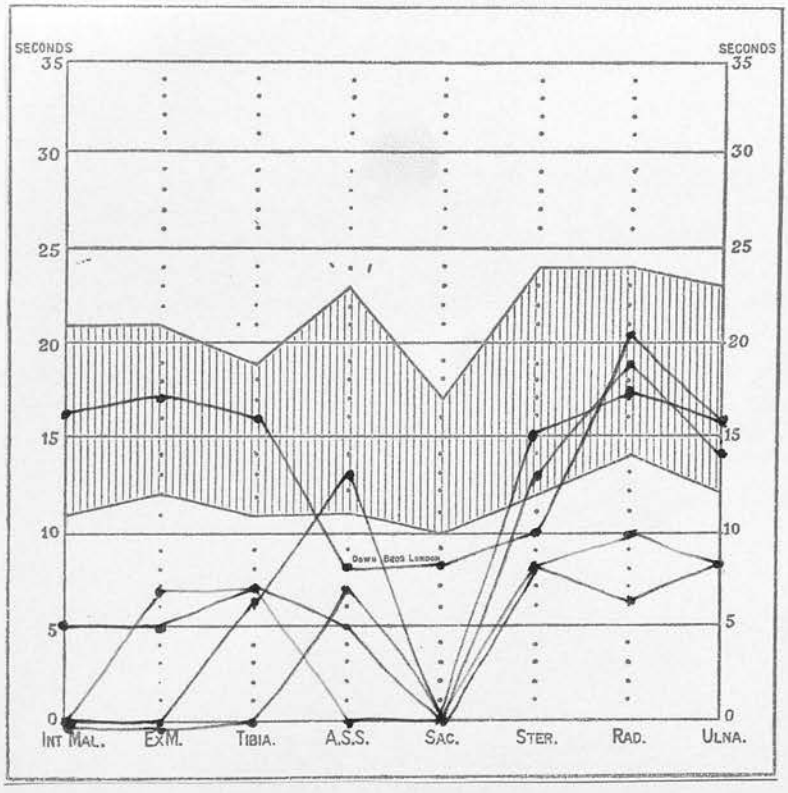
Treitel[34] originally described a loss of vibratory sensibility in tabes. Williamson[35] stresses its early appearance. Symns[32] demonstrated its typical graph when tested with his technique. He stated that there was always loss over the sacrum, usually over the lower limbs, occasionally in the upper limbs, and that there was a correlation between loss of vibratory sensibility and Rhombergism. Wood,[37] Ahrens,[2] Piercy[27] and Epstein[9] all agree with this. The five cases presented here are perhaps not suitable for confirmation of his work, as they are not borderline cases, but all typical chronic tabetics who had been attending the venereal diseases clinic for years. Their graphs all demonstrate clearly the features Symns described, especially the sacral dip. In only two of them was sensation diminished in the upper extremity. One of the patients, John Stenson, has the lowest sensibility of any case I have yet tested, having complete anaesthesia to vibration down the right side, in the sternum and pelvis, and diminished sensation in the left arm. (P. XLVI)

With experience it can only be said that each of these graphs is suggestive of tabes and not diagnostic. However, the compound graph of five cases can hardly be that of any other disease, i.e. the individual graph is not diagnostic, but the group is.

Disseminated Sclerosis.

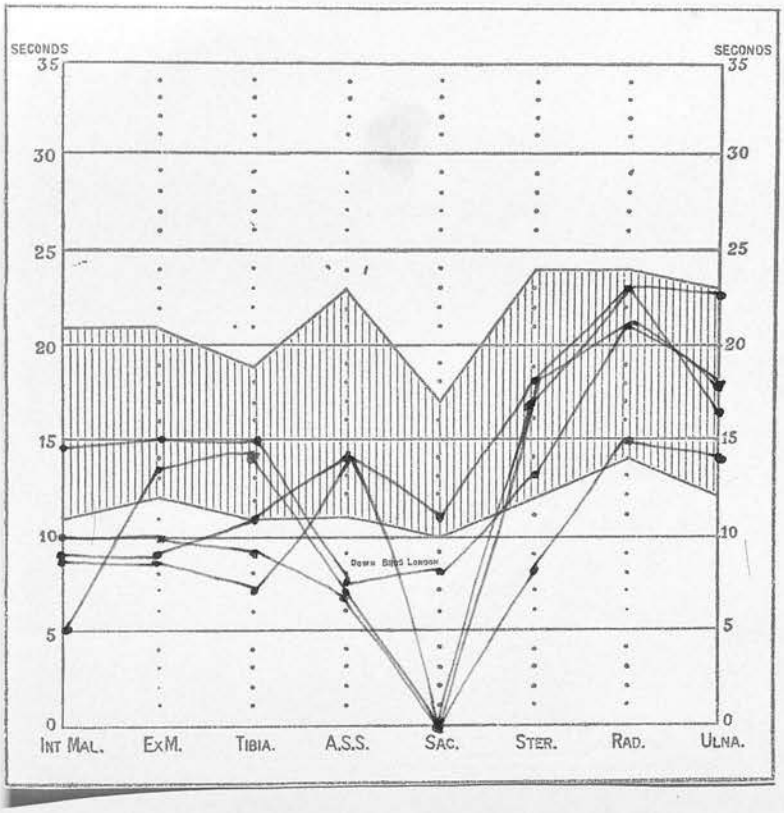
In this disease Williamson[35] stated that loss of vibratory sensibility was often the only sign of the disease in the sensorium. Symns[32] stated that there was always a loss over the sacrum, and sometimes over the long bones. In this series all had loss over the sacrum, and loss or diminution in the limbs, except for one case, who was the youngest, aged 29. Some of course had had the disease for many years. In view of the varying clinical picture of the disease it would be natural to find inconclusive findings in so small a series. However interest lies in the fact that one sensory change can nearly always be found in this disease where sensory disturbances are often hard to demonstrate.

DISSEMINATED SCLEROSIS
5 CASES



Microcytic Anaemia

5 Cases



Diabetes..

Williamson,[35] Symns,[32] Ahrens[2] and others describe loss of the sensation of vibration in diabetes.. Williamson states that the loss is often so slight that it can only be demonstrated with the tuning fork and that it is often worse on the side affected by gangrene or ulcers. Ahrens agrees. I have not found that the presence of arterial changes in the limbs usually causes diminution on the affected side.

The following table shows the incidence of absent or deficient sensation of vibration in the twenty-five cases.

	Sensation absent.	Sensation deficient.	Sensation absent or deficient.
Ulna	1	0	1
Radius	1	0	1
Sternum	0	5	5
Sacrum	9	5	14
Ant. Sup. Spine	5	2	7
Tibia	4	4	8
External Malleolus	5	5	10
Internal "	4	5	9

It will be noted that there is derangement at the sacrum in 14 cases, or 64%. Sensation was never absent at the sternum. In the fifty-five cases of derangement at the points tested, twenty-six showed only diminution and not loss. This would probably not have been found out had not Symns' technique been used.

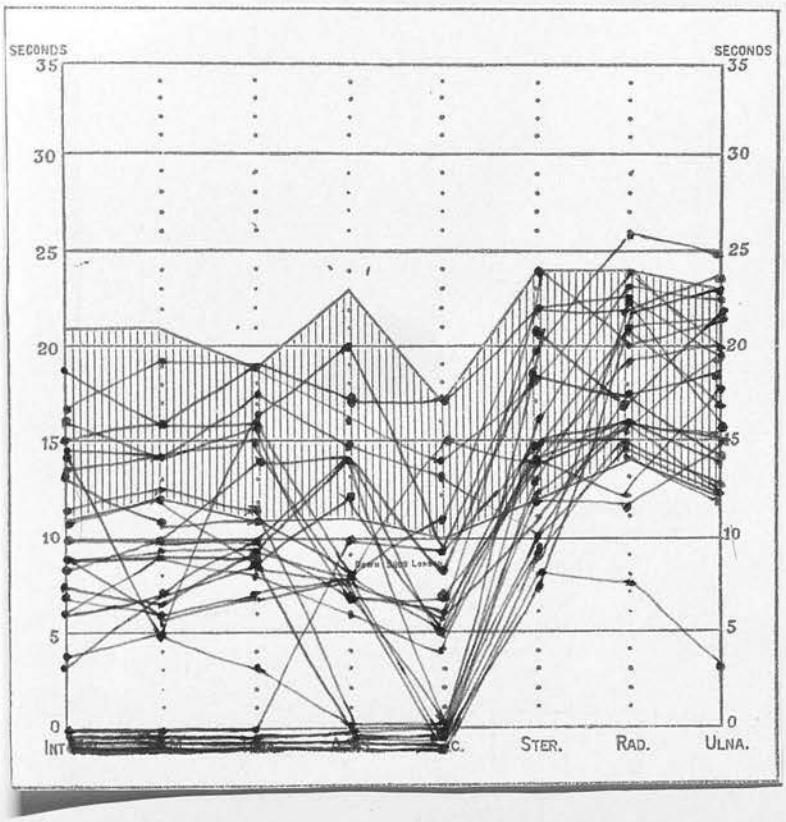
According to Symns' theory two of the cases are pure

peripheral neuritis, without cord involvement, and five cases show cord involvement without peripheral neuritis. This is hardly likely to be the true state of affairs, and it cannot be granted that absence of sensation of vibration at the sacrum is a sign of a cord lesion. Five further cases show a deficiency both in the limbs and in the pelvis. Twelve of the twenty-five cases, or 48% show changes that definitely point to a lesion of the nervous system, probably a peripheral neuritis, with a possibility of one or two cases having a cord lesion. According to Weltmann (30) subacute combined degeneration of the cord does occur in diabetes.

Three cases show marked difference between the two sides of the body, the sensation on the right side more acute than that on the left in one case, and the left more acute than the right in two cases.

DIABETES

25 CASES



Pernicious Anaemia.

The history of the description of nervous lesions in pernicious anaemia is interesting. Addison[1] did not describe lesions of the central nervous system in his original description of the disease. Biermer,[3] the next main worker on the subject, described weakness, giddyness and palpitations in the disease, and found capillary haemorrhages in the brain. In the early days subacute combined degeneration of the cord was confused with tabes. It was left to Déjerine[6] to point out the loss of deep sensibility in subacute combined degeneration, and its relation to pernicious anaemia. He also described the symptoms as due to lesions of the long fibres in the columns of Goll and Burdach.

Woltmann[36] suggested that some of the nervous lesions might be the result of a peripheral neuritis. Hamilton and Nixon[16] carried out this idea still further, and believed that the remissions in the nervous symptoms might be due to the healing of the neuritis, and not to cord involvement. They based their conclusions largely on pathological data. Bramwell,[5] on the other hand, stated that absence of lesions of the peripheral nerves was a feature of the disease. Were Symns' theory regardingpresence or absence of vibratory sensibility at the sacrum and limbs correct, this would quickly solve the problem. It is discussed further on.

Hamilton and Nixon found that loss of vibration sense was the commonest sensory deficiency found in subacute degeneration of the cord, being commoner than loss of the sensation of position, touch or superficial pain.

Various workers have estimated the percentage of lesions of the central nervous system in pernicious anaemia. Some estimates are as follows:-

Bramwell[6]	2.8
Nonne[26]	11.7
McCrae[21]	25
McPhedron[23]	40.9
Henneberg[18]	50
Gray[15]	66.6
Hamilton and Nixon[16]	80
Woltmann[36]	80.6.

Symns,[32] Williamson[35] and Friedman[12] emphasise the use of the tuning-fork in subacute combined degeneration, the latter considering it to be one of the most efficient tests.

Gray[15] made a fairly complete examination of a series of pernicious anaemia cases with his special tuning fork, and found that the amplitude felt showed an increase in pernicious anaemia which was not sufficiently large to be diagnostic in the arms but was so in the lower limbs.

Here is the table embodying the results of the examination of twenty-five cases of pernicious anaemia -

	Sensation absent	Sensation diminished	Sensation absent or diminished
Ulna	0	6	6
Radius	2	3	5
Sternum	0	6	6
Sacrum	14	4	18
Ant. Sup. Spine.	11	6	17
Tibia	7	8	15
External Malleolus	12	5	17
Internal Malleolus	12	6	18

In no case was the sensation absent at the sternum or ulna. At 102 points tested there was derangement of sensation, but diminution only in 44 of them. There was derangement at the sacrum in 18 cases, or 72%

According to Symns' theory there are four (in my group) cases of pure peripheral neuritis, four cases of pure cord lesions, and ten cases where the lesion lies in both the cord and peripheral nerves. In view of the large number of cases of diabetes and secondary anaemia who should have cord lesions according to this theory, it is difficult to accept it.

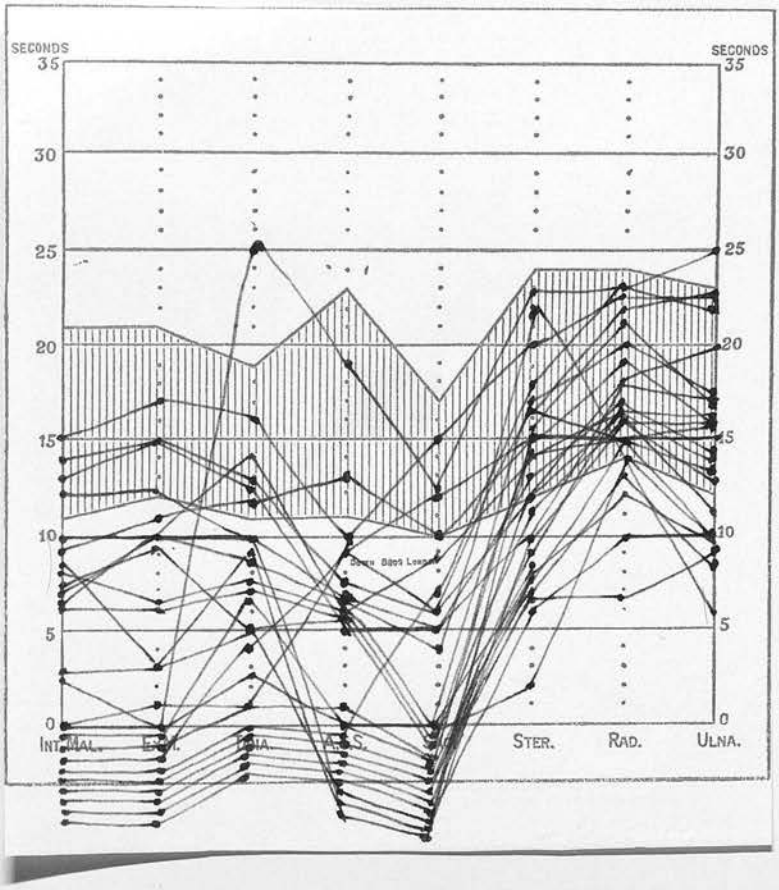
Eighteen of the series are shown by the tuning fork to have definite lesions of the nervous system. This is 72%, and the percentage would doubtless be higher were other criteria used as well as the sense of vibration as a sign of nerve lesions, and would doubtless approach that given by Hamilton and Nixon, and Woltmann of 80%.

It is of interest that Gray, with his complicated electrical tuning fork found diminution of vibration in only 66% of his cases of pernicious anaemia. Ahrens[2] stated that none of his cases had normal sensation of vibration. In my series four were normal and three doubtful. The average age of the normal cases was 40 years, and of the whole group 54 years. Possibly, in time to come, all pernicious anaemia cases, if they live long enough, will develop lesions of the cord.

Six patients had sensation which was markedly different on the two sides of the body. In two the right side was more acute than the left, and in three the left more acute than the right. In one the relative acuity of the two sides was reversed at different points.

PERNICIOUS ANAEMIA

25 CASES

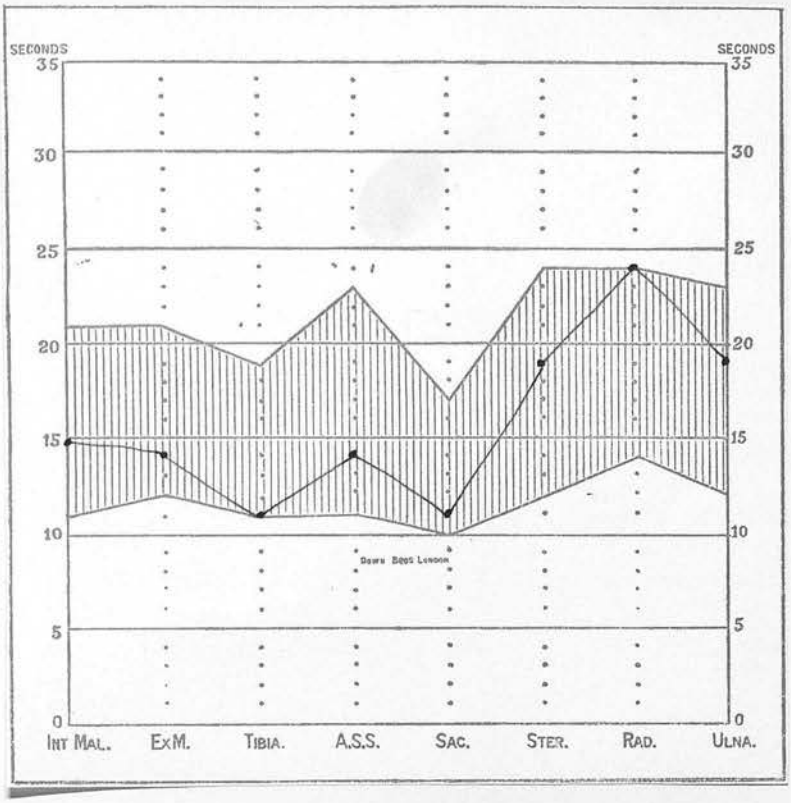


A series of cases, twelve in number, are shown to illustrate special points or to demonstrate the value of the use of the tuning-fork, or even, occasionally, the added confusion to which its use might give rise.

Subdural Haemorrhage.

One case was seen, the result of a fall. It was diagnosed after lumbar puncture and evidently adhesions resulted causing a block in the canal, giving rise to Froin's syndrome and a hold up of lipiodol given by cisternal puncture. The vibration sensation was normal, showing that there could not have been much damage to the posterior roots or columns. This was proved by the clinical course of the disease, the patient making a perfect recovery with no surgical interference.

Here may be mentioned some conflicting views in the literature, Williamson (35) stating that there is no loss in cord tumours and haematomyelia, Epstein (9) stating that there often is. On purely anatomical grounds it is obvious that the site and extent of the lesion would be the deciding factor.



Subdural spinal haem.

George Herbert Clegg (14)
560, Wakefield Road,
Huddersfield.

Christmas Day, 1934, fell on to back. Three days later pain in sacral and lumbar region. About New Years Day difficulty in walking. Lumbar spine tender and immobile. Feet very cold. Knee jerks and ankle jerks absent. Plantar reflex flexor. Abdominal, dartos and cremosteric reflexes absent.

Flexors of knee and ankle very weak. No sensory disturbances.

C.S.F. Only 2 ccs obtainable.)
W.B.C's = 6 per cmm) Froin's
Albumen = 1%) syndrome
Xanthochromia)

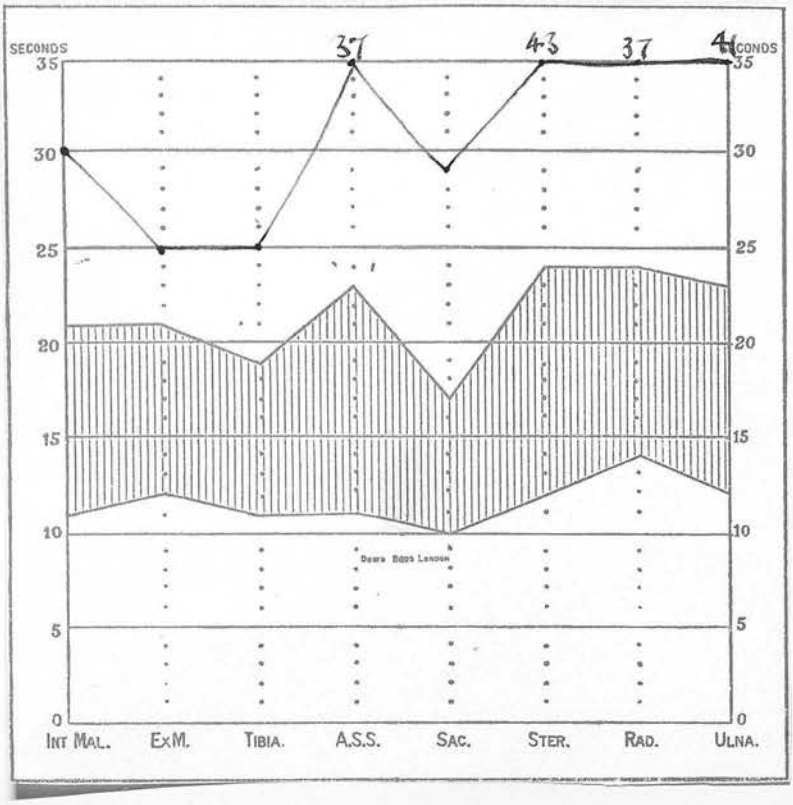
X-Rays. Small bony lesions in lower margin right side of 11th dorsal vertebra Lipiodol trickles down cord into sacral region but most held-up at second lumbar vertebra.

Intracranial Tumour.

An interesting but isolated case of intracranial tumour is presented. The site was not definitely diagnosed either in Huddersfield or by Mr. Geoffrey Jefferson of Manchester, but a suboccipital decompression gave much relief. The interest lies in the marked sensory acuity of the patient, the highest that I have yet tested, the readings being in some cases too high to plot on the graph. In addition the patient was markedly sensitive to pain of all kinds, intravenous injections causing him much discomfort. It is useless to speculate on any relationship between intracranial tumours and vibratory acuity, but it would be interesting to investigate a series with this relationship in view. One other case of cerebral neoplasm in an old man showed fairly normal readings.

Syringomyelia.

Williamson[35] states that there is no change in the vibration sense in syringomyelia, and Epstein[9] that there might be. The only case in this series was rather atypical, all signs pointed to an upper motor neurone lesion, with no wasting of the muscles of the hands. In only one small area internal to the nipple was there loss of sensation to temperature and pain. The sensation of vibration showed marked diminution in the extremities.



Cerebral Tumour.

James Manchester (23)
281, Alder Street,
Fartown.

Headaches, tingling in arms, with cramps when warm.

Choked discs
C.S.F. pressure > 300
W.R. & blood, N.A.D.

X-Ray skull. Sella on large side, but not pathological.

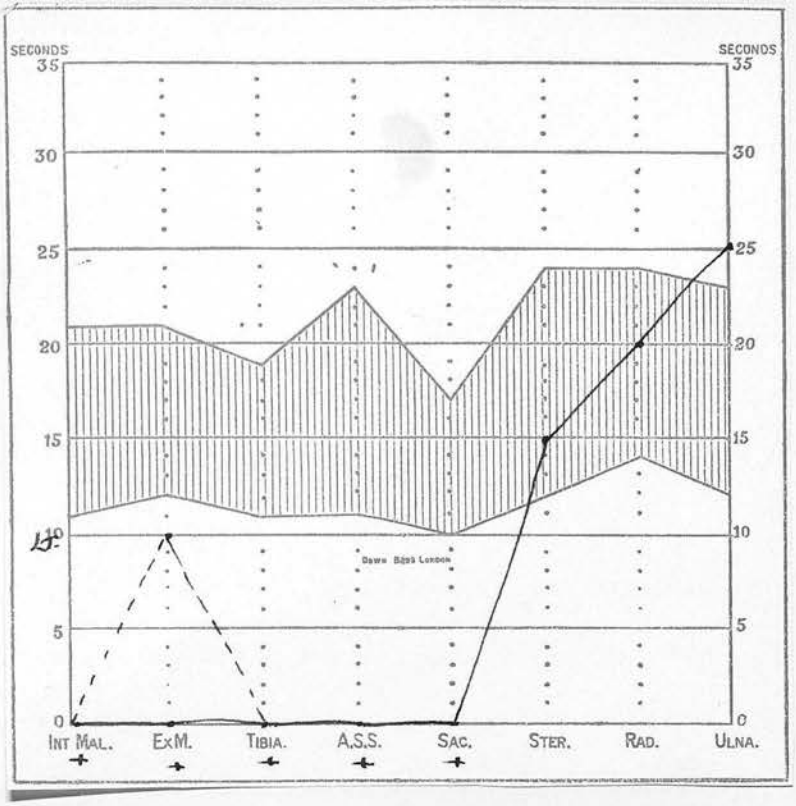
Facial nerve. Slight weakness of facial muscles on right side, on lower part face.

Reflexes All brisk, including jaw jerk.

No muscular weakness or inco-ordination.

Sensation normal, vibration + +

Tumour not localised. Sub-occipital decompression performed by Mr. Jefferson with much relief.



Syringo - myelia

Leonard Steele (47)
39, Quarmby Fold, Lindley.

Uncertain gait, getting worse for years.

Deep reflexes all + +
Plantar reflex flexor
Ankle clonus, patella clonus.
Wasting of left calf.
Absent abdominals.
No loss of muscular power.
On small area internal to left nipple complete inability to distinguish between hot and cold. Also response to pricking less keen in same region, which can be marked out.

Other sensations normal.

C.S.F. normal.

W.R. normal.

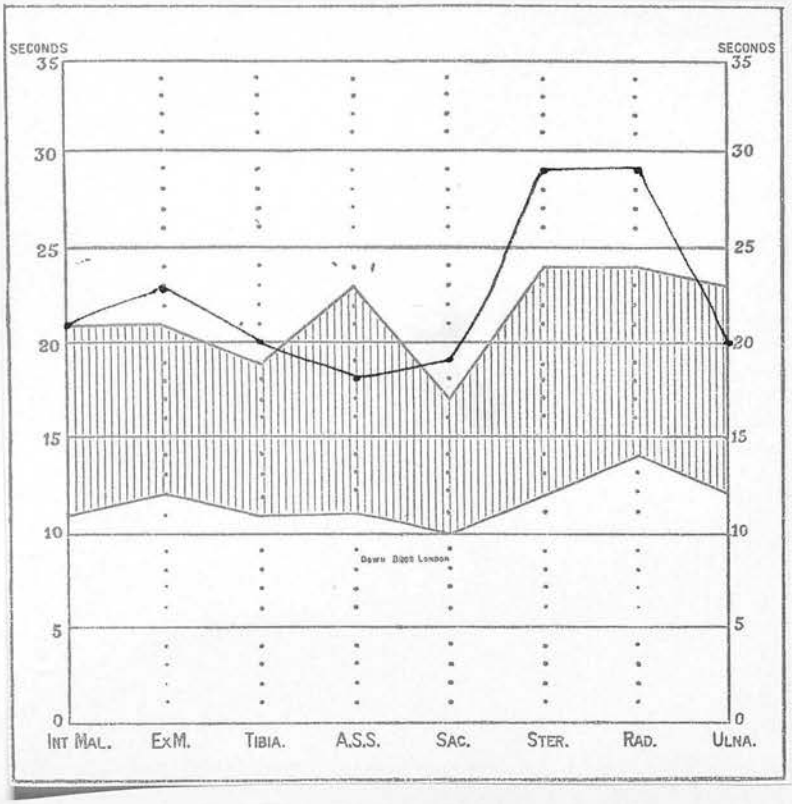
It was rather difficult to come to a diagnosis either with or without the help of the tuning fork, but there seems to be no reason why a cavity in the cord, if large enough, should not destroy part of the columns of Goll and Burdach, thereby reducing vibratory acuity.

Hemichorea.

To illustrate the absence of changes of the sensation of vibration in lesions of the brain, a case of hemichorea, probably the result of encephalitis, is presented. The patient had choreiform movements confined to the left side of the body. In view of the known sites affected in both encephalitis lethargica and lesions giving rise to chorea, i.e. the basal ganglia and the mid-brain, it is interesting that the sensation of vibration should have escaped entirely.

Cerebro-Spinal Syphilis.

According to the course of the impulse conveying vibratory appreciation, lesions of the secondary neurones should not give rise to diminution of vibratory acuity. Hence there is a loss in tabes, but in a pure case of G.P.I. there should be no change. Piercy[27] insists that the curves of G.P.I. should be normal, but Ahrens[2] found that while three of his cases had a normal graph, two others had a tabetic one. It is difficult to be dogmatic as so many cases are a mixture of the two. Of two cases illustrated one is a mixture of tabes and an upper motor neurone lesion; the graph is tabetic. The other patient has signs and symptoms of syphilitic meningo-myelitis. The vibratory acuity is



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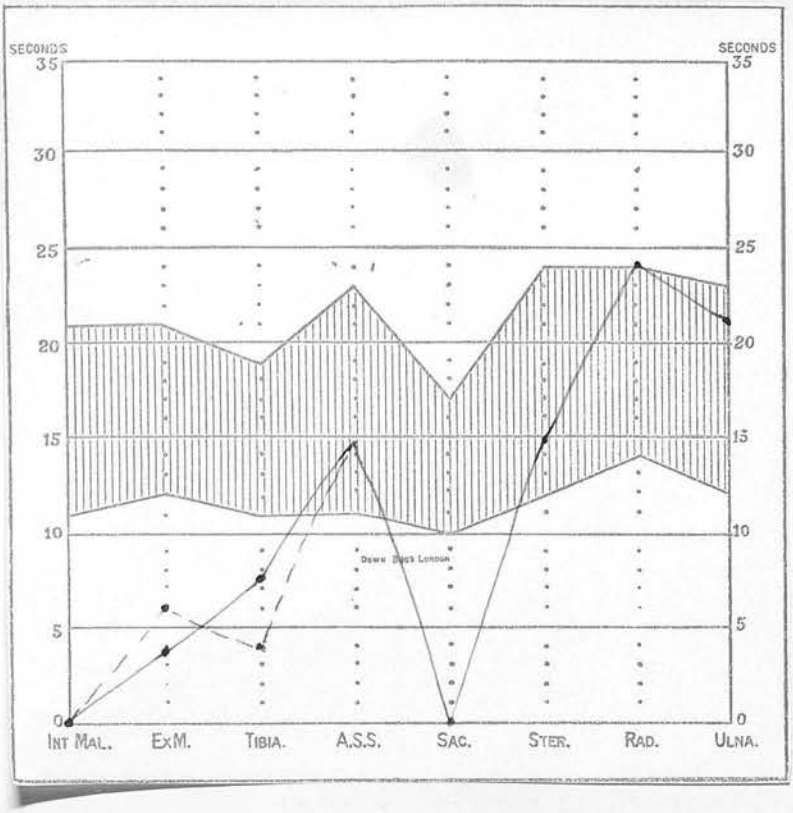
Hemichorea

William Hepworth (30)
21, Longfield Avenue,
Dalton.

Choreiform twitching of left hand, to a less extent of arm, for 4 years. Worse in winter. Does not interfere with job. Began four years ago, after an illness manifested by vomiting, diarrhoea, abdominal pain and a dazed feeling, which illness caused three months absence from work.
Left quadriceps and foot also involved. Commencing left sided talipes.
Twitching disappears with purposeful movement.
Pin and needles in left finger-tips, during last fortnight.
Has seen double on two occasions whilst driving (fatigue?)
Examnation. Nystagmus to right and left. Mouth drawn up very slightly to left side, and creases more marked on that side.
Reflexes Jaw jerk + +. Deep reflexes of upper extremity brisk. Upper abdominals absent. Lower abdominals present.
Cremasteric reflex present.
Knee jerks brisk. Ankle jerks brisk.
Plantar reflex extensor on left. No clonus.
Muscular power normal. Slight wasting of left calf. No sensory disturbances.

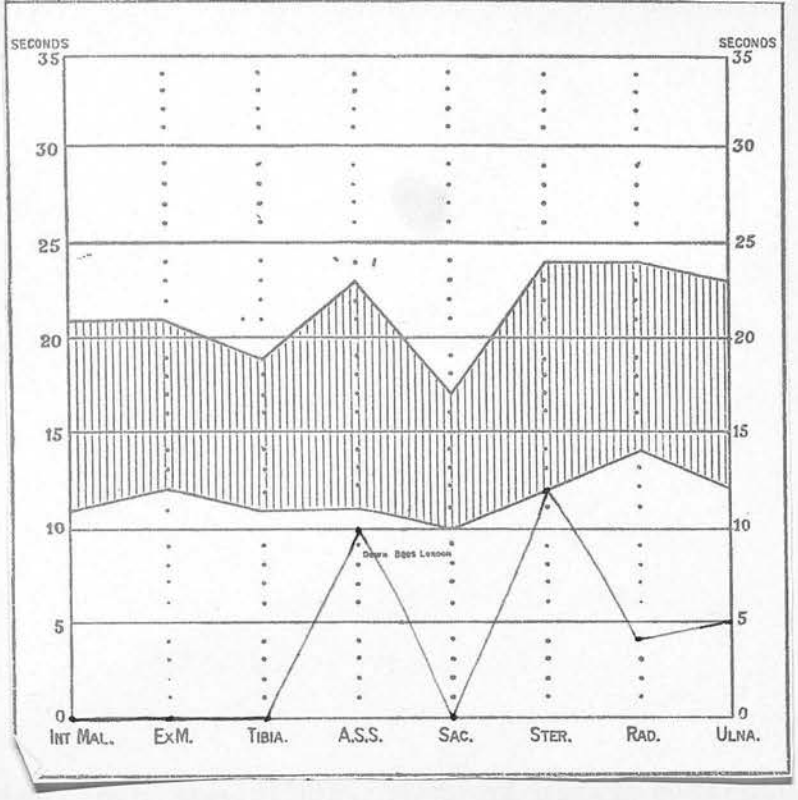
C.S.F.)
W.R.) - N.A.D.



Tabo - Paresis

Arthur James Beckenham (62)
25, Manor Street, Newsome.

Five weeks ago complained of dizziness.
In Army 1891-1902, rejected for medical reasons in 1914.
Lungs N.A.D.
Heart. Apex-beat displaced. downwards. Double aortic and mitral systolic murmurs.
B.P. 145/100
Flabby abdomen. Appetite good.
Habits. 6 pints a day, 1oz tobacco a week.
Slight Rhombergism and a trace of ataxia.
Insomnia for last fortnight. Memory good, speech normal. 2 children, both dead (one stillborn one with hydrocephalus)
Chancre 1896.
No trouble c bowels or micturition.
C.N.S.
Muscles Flabby but not much loss of power.
Reflexes Deep ones present but weak, except ankle jerks, which are absent.
No clonus or plantar response. Abdominals, cremasteric and dartos reflexes not elicited.
Sensation Nothing abnormal found, except marked deficiency of vibration at malleoli and sacrum
Also rather insensitive to deep pressure on calves.
No inco-ordination elicited.
Coarse tremor of lips, muscles around eyes and of hands, elicited on effort.
Cranial Nerves
1. Smell deficient 8. Left ear rather deaf. 12.
Tongue deviates slightly to left.
Fundi. normal.
W.R. Doubtful.
C.S.F. N.A.D.



Syphilitic Meningo-myelitis

Henry PUGH (42)
66, Handel Street,
Golcar.

Pain in stomach and legs for 2 - 3 years, no relation to meals. For similar period difficulty in walking, right leg drags.

Pupils react to light.

All deep reflexes increased, knee and ankle and wrist clonus. Plantar response extensor. Abdominal and cremasteric reflexes absent.

Muscular power good, except for flexors of right knee.

Slight intention tremor and inco-ordination upper limb. In bed no inco-ordination lower limbs.

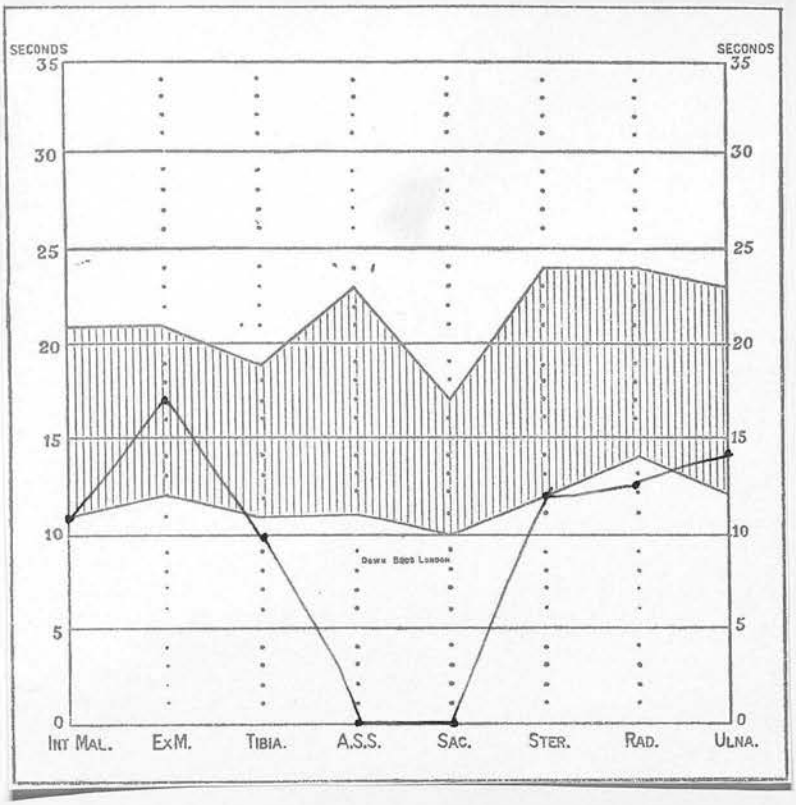
Deficient sense of vibration. Hyperaesthesia corresponding to thoracic segments 11 & 12. Otherwise no sensory derangement.

C.S.F. Pressure 90 mms. No block.
W.R. - has been + . C.G.T Luetic. Infected 1919.

generally diminished, but absent at the sacrum and the malleoli. Again the graph is suggestive of tabes, but it ought to be made clear that a tabetic curve can be found in many diseases, such as disseminated sclerosis, or sub-acute combined degeneration of the cord.

Amyotrophic Lateral Sclerosis.

This disease, being purely a lesion of the motor neurones, should display no diminution of the sensation of vibration. In one of the illustrative cases this is the case, but the other, that of Higgs, presents an interesting problem. This patient has all the signs and symptoms of a pure upper motor neurone lesion, but has absent vibratory sensation at the sacrum and anterior superior iliac spinex. Should this be sufficient to change the diagnosis? In this case I believe not, as the individual was rather fat, and had thickened arteries, which if present in the lumbar cord would suffice to cause this deficiency. It is interesting as a confirmation of his sensory integrity that the sensation in the lower extremities is normal. Usually, with a man of his age, absence of sensation at the sacrum is accompanied by some diminution at the limbs.



AMYOTROPHIC LATERAL SCLEROSIS

Joseph HIGGS (51)
Old Road, Overton, Wakefield.

Inability to walk, due to weakness of legs.

Breathlessness, swelling of feet.

B.P. $\frac{130}{90}$

Has been a large drinker.

All muscles weak, all deep reflexes exaggerated. Ankle and patella clonus and plantar reflex extensor.

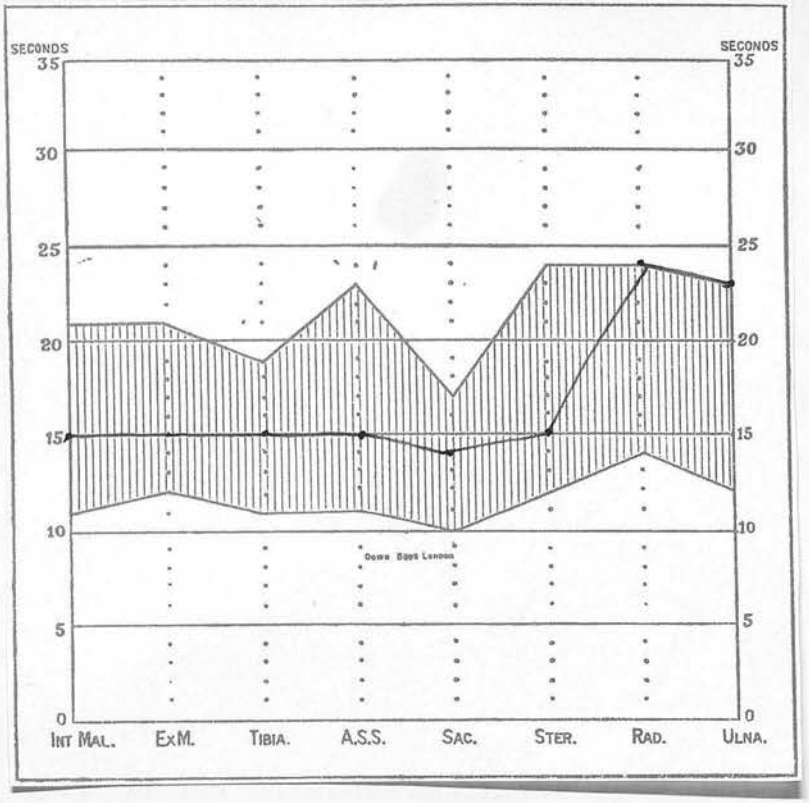
Abdominal reflex present left side.

Clonus? at wrists.

Severe muscular cramps of legs.

No sensory disturbance.

C.S.F. W.R. Fundi all normal



AMYOTROPHIC LATERAL SCLEROSIS

Harry RIDSDALE (30)
53, East Street,
Lindley.

Friends have noticed a limp for the last three years.

Reflexes of ankle Knee and ankle jerks + +. Clonus and knee. Plantar reflex extensor.

No muscular changes.

Difficulty in appreciation of heat cold, and pin pricks in abdomen and arms, but probably not organic.

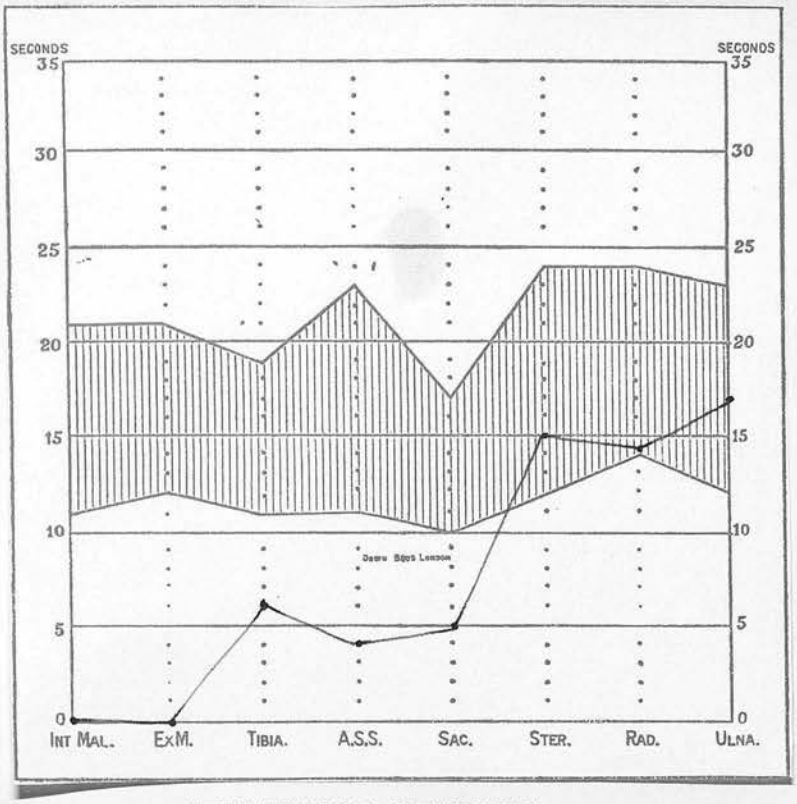
No other sensory loss.

W.R.) Normal
C.S.F.)

Peripheral Neuritis.

All writers concur that vibratory sensation is diminished in peripheral neuritis. Symns[32] states that the sensation is usually present in the sacrum, but absent in one or other of the extremities. In diabetic neuritis he declared that the arms were normal, but the legs affected. In alcoholic neuritis both arms and legs were affected, and in plumbic neuritis usually the legs and less so the arms. Of my twenty-five cases of diabetes, only one had diminution in the arms, but fifteen in the legs.

Two cases of peripheral neuritis, both of unknown origin, and one acute, are presented here. Both show typical curves, the sensation being present at the sacrum, but absent at the limbs. In both of them the tuning fork was of help in coming to a diagnosis. In this disease the sensation of vibration is usually the first to disappear and is often deficient before the knee-jerks are absent. This is well shown in the case of Lawford. His knee-jerk was present on the left side, but the tuning-fork, although felt in the middle of the shaft of the tibia could not be felt at the malleoli. His knee-jerk was absent on the right side, and the sensation of vibration lost in the whole tibia as well as at the malleoli.



PERIPHERAL NEURITIS

George BRIDGEWATER (52)
Park Mill,
Clayton West.

Reflexes Triceps, brachialis, upper and lower left, lower right abdominal reflexes absent, also knee and ankle jerks absent. Plantar response flexor.

Muscular Power, Good; but flexion of left thigh poor. Wasting of legs.

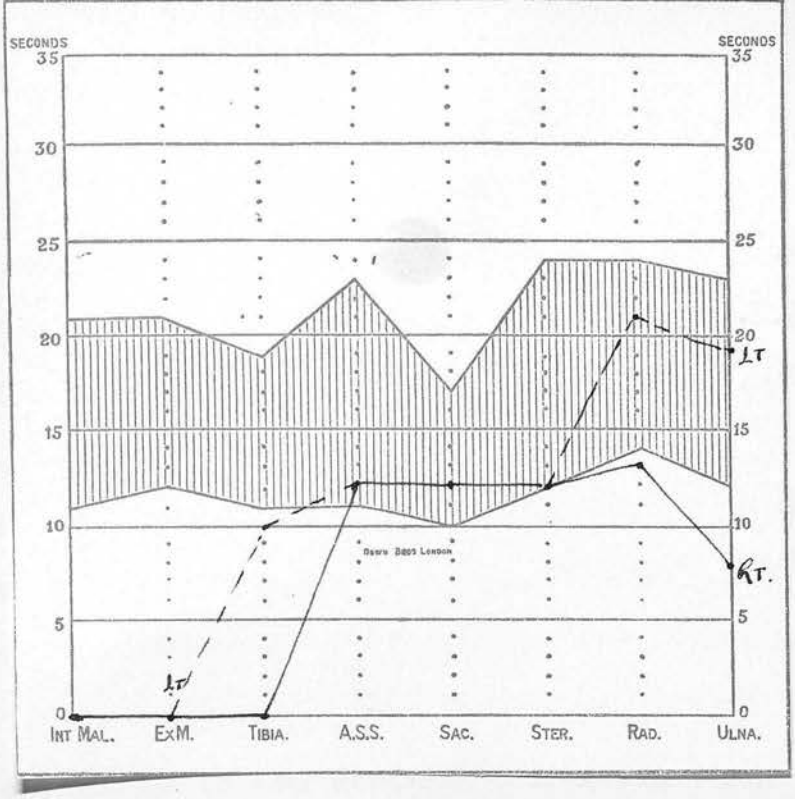
Inner side left leg, poor appreciation of heat and cold, and delay in appreciation of stimulus of prick. Various ill-defined areas of hyperaesthesia, no anaesthesia.

No real inco-ordination. Much pain in legs, also in abdomen.

X-Ray shows osteophytes on anterior surface of vertebrae.

W.R. and C.S.F. negative.

Fundi, arterio-sclerosis B.P. 150/100



PERIPHERAL NEURITIS

Frank LAWFORD (52)
86, Willow Lane,
Huddersfield.

Five weeks ago chill and sore throat. Confined to bed. Swelling of ankles and hands a fortnight before admission.

Haematuria from the first. Now absent.

Pain in right leg, two days before admission. Now some pain in left leg.

Bronchitis.

Heart Gallop rhythm. Left ventricle enlarged to nipple line.

B.P. $\frac{150}{75}$

Drink $\frac{1}{2}$ pint a day.

Loss of power and sensation in limbs began suddenly two weeks before admission.

Exam Extensors of right wrist very weak. All muscles acting on ankle very weak.

Knee jerks and Ankle jerks present on left - absent on right side.

Sensation deficient on dorsum hand, both feet and external side left leg.

P.T.O.

W.R.	negative
C.S.F.	N.A.D.
N.P.N.	57 mgms %
Hb	40%
R.B.Cs	2,810,000
W.B.Cs	24,000

Films, polymorphonuclear lencocytosis.

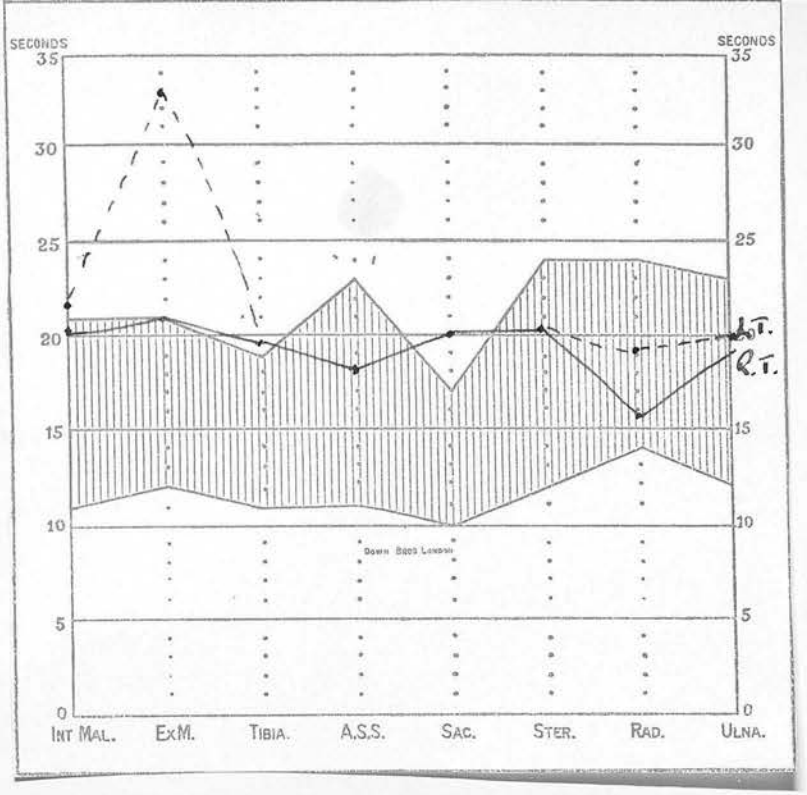
Lead content of urine nil.

Blood culture sterile.

Hemiplegia.

Head,[17] Epstein[9] and others have discussed the effect of cerebral lesions on the sensation of vibration, usually there is little loss, but if there is other sensory diminution there is often some deficit of the sensation of vibration. It is never completely lost however, except in cases of neural shock. The protopathic component of the sensation, or what Head calls the "jarring," is probably felt in the thalamus, and the epicritic in the cortex. In haemorrhage in the internal capsule there is said often to be a diminution, or feeling of distance, in the sensation. On the other hand, when the thalamus is irritated, or divorced from the cortex, the sensation is often extremely unpleasant, or even painful, and may be felt stronger than in the sound limb. This applies to other sensations as well as vibration, such as tickling or pin-pricking, and was described by Roussy under the name of "syndrome thalamique."

Of the two cases of hemiplegia presented, both aspects are involved. In the case of Fisher the sensation in the paresed limb was felt as long as in the normal limb, in spite of the fact that the patient averred that the sensation was much weaker on the paralysed side. The other patient showed clearly the "syndrome thalamique", as when the fork was applied to the external malleolus of the affected side, he cried out with the discomfort and attempted to withdraw his foot. The sensation was felt there much longer than in the normal limb.



CEREBRAL HAEMORRHAGE $\frac{}{c}$ HEMIPLEGIA

Robert Louis CURTIS (28)
19, Roundwood Avenue,
Waterloo.

Dropsy aet 5. Iritis twice.
Chronic rheumatism. Epistaxis, five months ago, lost much blood.

On night before admission twitching began in right eye. Left arm and leg became paralysed. No loss of consciousness.

Has had frequent headaches above right eye.

Lungs N.A.D.

Heart Forcible apex beat, in 5th space, $5\frac{1}{2}$" from mid-line. Accentuated aortic second sound.

Bradycardia. Arterial wall hypertrophied.
B.P. $\frac{210}{150}$.

C.N.S. Complete left sided hemiplegia.

Fundi Oedema of discs and haemorrhages.

N.P.N. 53 mgms %

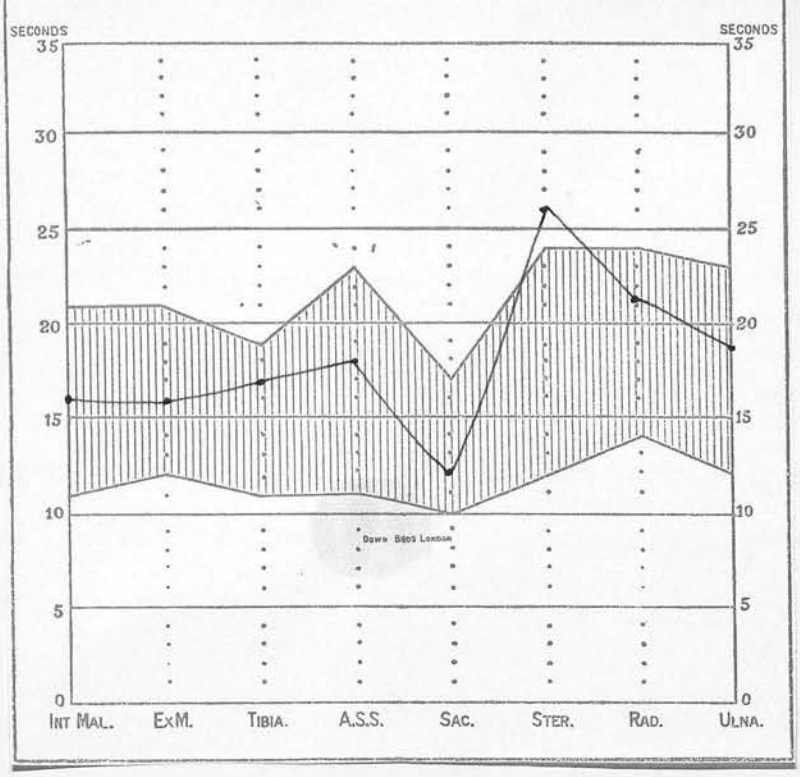
Urine Albumen present. Wet films show hyaline and granular casts, red blood corpuscles, pus cells.

1.3.35. Meningeal irritation.

P.T.O.

General condition improving but not hemiplegia.

States that vibration feels far more distant on paralysed side, although he feels it longer. On left external malleolus he experiences pain, and foot twitches.



HEMIPLEGIA

William FISHER (56)
35, Thomas Street,
Huddersfield.

1923 Burnt badly.

1931 In hospital with peptic ulcer.

1932 Haematemesis. Gastro-enterostomig.

Anaemic for 2 years.

Hemiplegia 12 months ago.

Malaria 32 years ago.

Habits. Until 3years ago took 20 pints of beer and 60 - 70 cigarettes daily. Now 2 pints and 12 cigarettes.

Examination Anaemic

Pain in stomach, always present, worse at night. Bad for 4 months. Vomits bile occasionally.

Cough for 2 months.

Lungs and heart N.A.D.

B.P. $\frac{180}{110}$

Abdomen Tenderness in epigastrium, to both sides of mid line.

Complete picture of upper motor neurone lesion on right side.

P.T.O.

N.P.N. 37 mgms %

Hb 32%. R.B.Cs 3,720,000. W.B.Cs 7,400
C.1 0·5

Microcytosis, poikilocytosis, polychromasia.

F.T.M. Achlorhydria, blood.

X-Ray Small irregular stomach stoma acting well, but evidence of ulcer to left of opening.

Stool Positive for occult blood.

W.R. Negative

States sensation of vibration to be more distant on paresed side.

Discussion.

The sensation of vibration is the most delicate known test of the integrity of the posterior columns of the cord. The great advantage of testing according to Symns' technique, which is rarely carried out, is that a quantitative result is obtained, thereby providing an indication of small changes, and giving a graph which can be compared with the results of testing the patient at some future date.

The sensation of vibration is definitely related with that of deep pressure and passive movement, and the sensation, especially at the sacrum, shows a correlation with the presence or absence of Rhombergism. To a less extent the sensation can be felt in the skin, like that of touch, and this small component of the sensation can be abolished by local anaesthesia.

The fork is conveniently applied to some bony prominence, as thereby the bone is made to vibrate and distribute the impulse through the soft tissues. Disease or fracture of bones has little effect on the duration of the sensation, and probably only a very small part of the sensation is felt in the bony tissues themselves. The sensation is perceived in the cerebrum; a protopathic element in the thalamus, and an epicritic in the cortex.

With practice, in a normal individual, the acuity of the perception can be considerably increased, and is found to be so increased in healthy blind individuals. The sensation is diminished by fatigue, of which there are two forms,

extrinsic fatigue, due to tiring of the organism as a whole, and intrinsic fatigue, due to overstimulation of the sensation of vibration itself. It is the neglect of this latter factor that is the chief error in testing by Symns' method, and a simple method of overcoming this has been devised.

It has been frequently stated in the literature that diminution of the sensation at the sacrum denotes a lesion of the cord, whereas diminution at the limbs and a normal sensation at the sacrum means a peripheral neuritis. With the latter assertion I have no dispute, but it is impossible to accept the fact that absence of the sensation at the sacrum necessarily means a cord lesion. Were it so five of my cases of diabetes would have pure cord lesions, and only two pure peripheral neuritis; three out of five cases of microcytic anaemia would have cord involvement, whereas only one had suggestive signs and symptoms; and a case of syphilitic aortic disease, with no signs or symptoms of nervous lesions, and a perfectly normal cerebro-spinal fluid, would also be diagnosed as such. Nevertheless, absence of sensation of vibration at the sacrum is suggestive, and should lead to further investigation. It should not be forgotten that the presence of a large sacral pad of fat is an element in reducing sacral acuity.

The tuning-fork is occasionally of advantage in detecting hysteria and malingering. In hemianaesthesia, if the fork is felt on one side of the sternum and not on the

other, the disease is probably functional, as the whole sternum is made to vibrate. Stated otherwise, in a case of anaesthesia of a limb, should the vibration not be felt when the fork is applied to a bone in the anaesthetic area, but be felt when applied to the same bone outside the anaesthetic area, the disease is probably hysterical. If the sensation of vibration is the only sensation to be diminished the disease is probably organic. In Rhombergism the sensation is almost certain to be diminished if the disease is organic.

Probably the greatest help which the tuning fork gives is in the diagnosis of pure motor lesions, such as acute anterior poliomyelitis, amyotrophic lateral sclerosis, progressive muscular atrophy, and their differentiation from combined lesions, such as multiple neuritis, transverse myelitis, disseminated sclerosis and subacute combined degeneration of the cord. But note must be taken of the diminution of the acuity with age.

Summary.

1. A brief resume of the history of the study of the sensation of vibration is given.

2. A few physiological principles involved in the perception of the sensation, and its course in the brain and cord are discussed.

3. Ten individuals without disease of the central nervous system were examined to correlate the normal with the investigations of others.

4. Five people above the age of 70 were examined to demonstrate the loss of vibratory acuity with age.

5. Five blind, but otherwise healthy individuals, were examined, and their vibratory acuity found to be above the normal, especially in the limbs.

6. Five cases of syphilitic aortitis were examined; sensation at the sacrum was absent in two, and the central nervous system diseased in one of these.

7. Five sufferers from post-encephalitic parkinsonism were tested, and their curves found to be rather low, but well within the normal. The feature of the curves was their evenness.

8. Five tabetics were examined, and their curves found to agree with the typical curve as described by Symns, showing the "sacral dip." One of the individuals had the lowest sensibility yet tested.

9. In four out of five cases of disseminated sclerosis there was marked diminution of acuity. The sensation of vibration is often the only sensation disturbed in this disease.

10. Five cases of microcytic anaemia are discussed.

11. Of twenty-five cases of diabetes 48% showed lesions of the nervous system. Fourteen had deficient sensation of vibration at the sacrum, but this could not have meant a cord lesion. In about half the cases of diminution of the vibratory sensation the loss would never have been found had not Symns' technique been used.

12. A brief resume of the history of nerve lesions in pernicious anaemia is given. In subacute combined degeneration of the cord the sensation of vibration is deranged more frequently than any other sensation. Of the twenty-five cases tested 72% showed nervous lesions. In two-fifths of the cases the loss was quantitative and would not have been found out had not Symns' technique been used. Four cases, or 16% had peripheral neuritis without cord involvement.

13. Twelve miscellaneous cases, to illustrate various points, are presented. One of these, a case of intracranial neoplasm had the highest vibratory acuity so far encountered.

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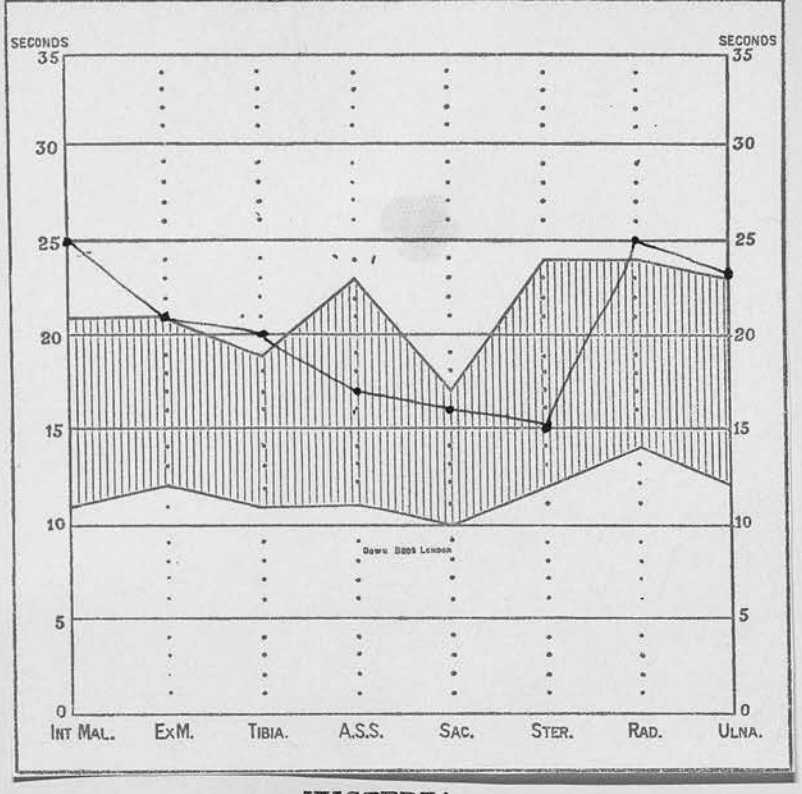
TEN NORMAL CASES.



HYSTERIA

Mabel ASHTON (28)
18, Hall Cross Road,
Lowerhouses.

Felt poorly a week before admission with slight discomfort in chest and fever.

11.15 a.m. on morning of admission had severe pain in chest, and could not move because of it. Laid down. Later on found that legs were numb and could not be moved. Burnt thigh with hot water bottle, due to absence of sensation.

Temporary retention of urine.

Exam. Active movement in both lower limbs. Sensation of heat and cold normal, also at site of burn.

Pain present in head, has travelled up from chest. Plantar reflexes apparently extensor.

Heart) N.A.D.
Lungs)
History of relative with similar complaint.

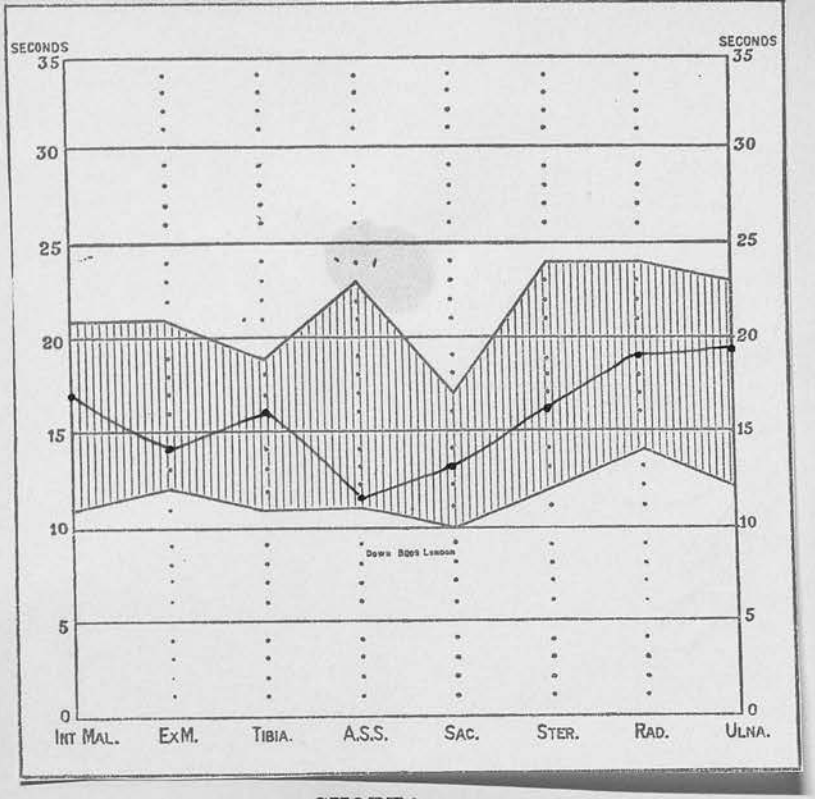
Right leg weaker than left. Knee Jerks and ankle jerks + +

10.4.35 Lumbar puncture, blood stained fluid!

Cisterna Puncture dry.

Weakness of rt. leg disappeared. Plantar reflex now flexor.

W.R. Negative.

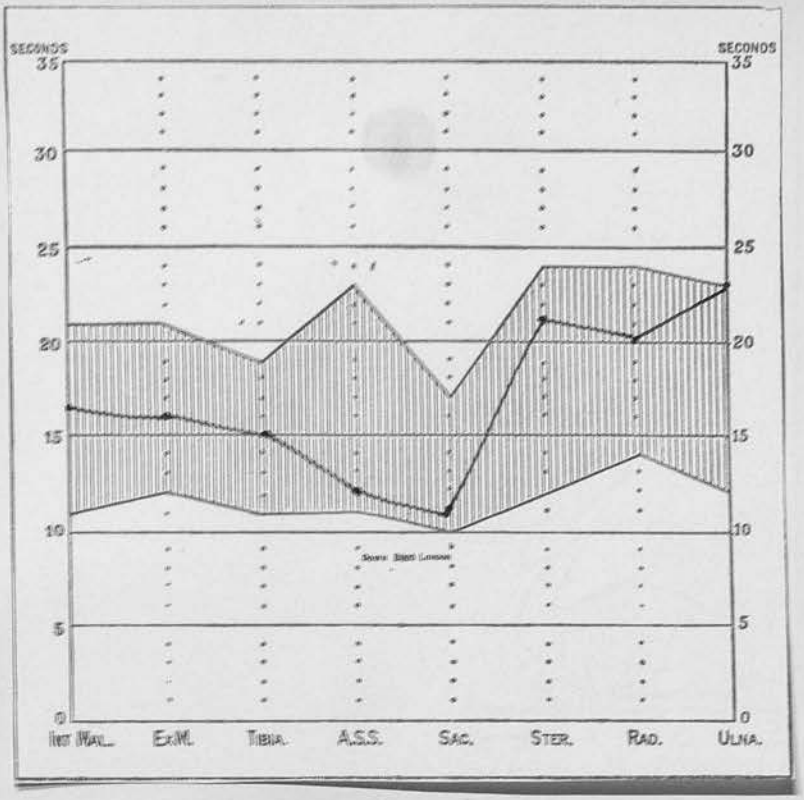


CHOREA

John BUCKLEY (12)
Upper Row,
Grange Moor
Wakefield.

22.6.34 Chorea.

Has been admitted three times for acute retention of urine, no structural lesion locally.



CHOREA

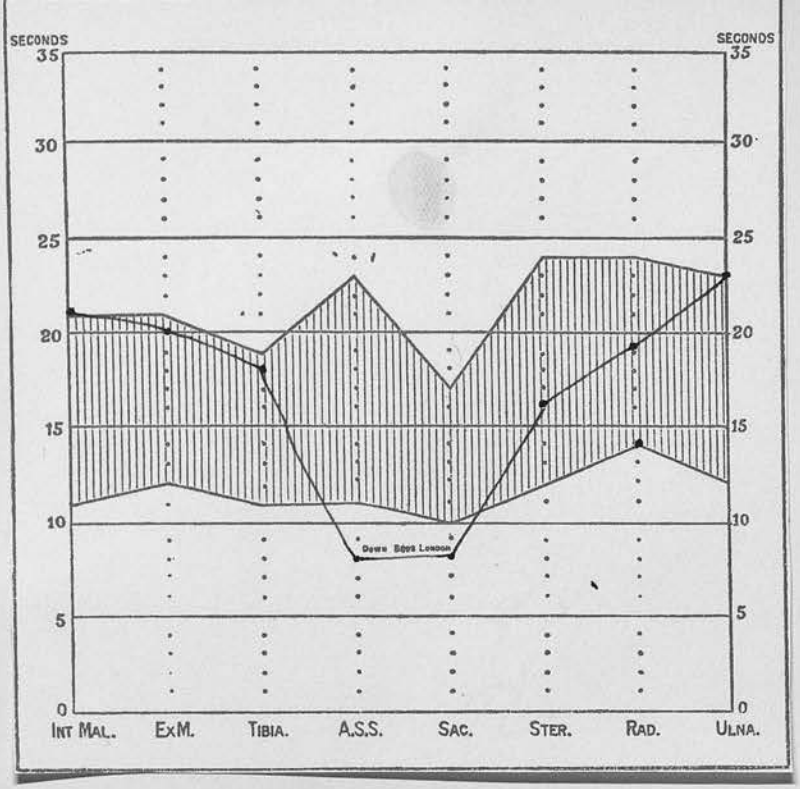
Edith COOMBS,
30, Hawthorn Terrace,
Carleton Street
Huddersfield.

Typical case of chorea, worst in legs.

Mitral Stenosis, lesion sounds active.

Rheumatic fever, four years ago, Chorea three years ago, rheumatic fever six months ago.

Scarlet fever seven years ago.



HYPERTHYROIDISM

Eva ELLIS (32)
Dalton Bank,
Colnbridge.

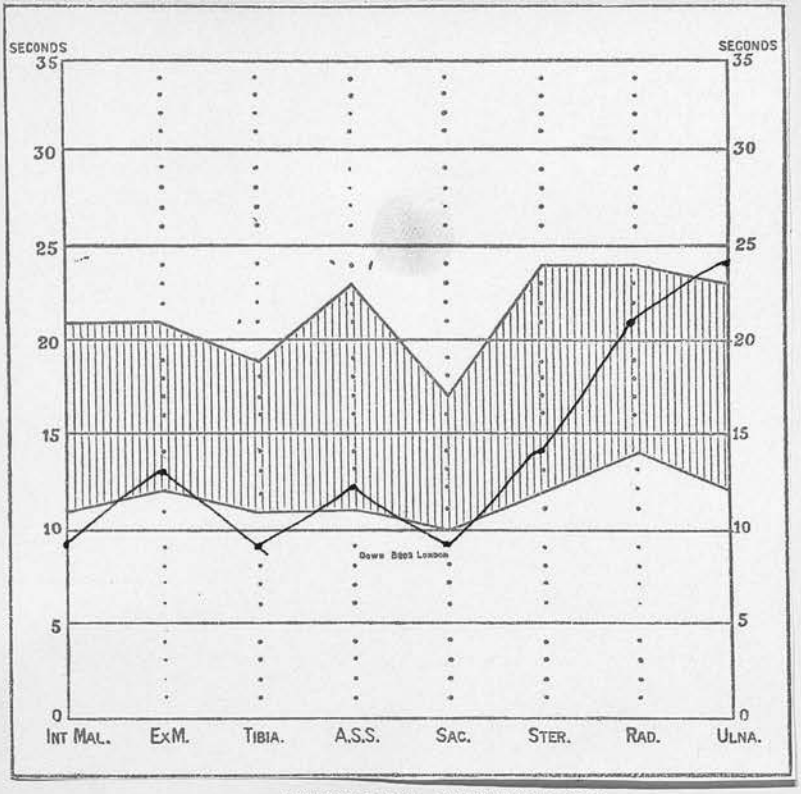
Dizziness. Pain along right side face.

Glands in right superior cervical triangle enlarged.

Exopthalmos. Thyroid not appreciably enlarged.

Pulse 100. Slight tremor. Eye signs.

B.P. $\frac{150}{110}$



EMBOLIC NEPHRITIS

Mary ENGLAND
Sunnyhurst,
Sunnybank,
Greetland.

Ill for 14 weeks. Pain in left lower chest. No cough. Pain on breathing. Pyrexian for 2 weeks. Jaundice for 3 weeks, after convalescence. Occasional rheumatic pains and vomiting. Pyorrhoea.

Urine Numerous pus cells. Hyaline, granular, epithelial and pus casts and R.B.Cs present.

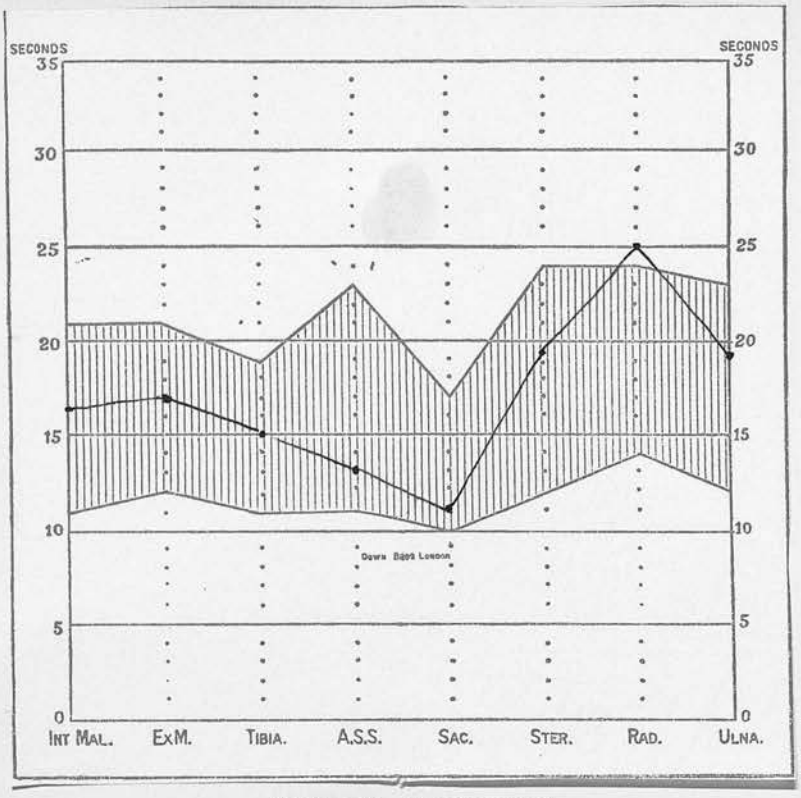
No T.B. seen.

Gram films. Few diphtheroid bacilli and streptococci
Cultures. Few colonies of streptococcus and diphtheroid bacilli.

N.P.N = 32 mgms %
W.B.Cs = 14,600

Guinea-pig inoculation negative.
X-Ray chest N.A.D.

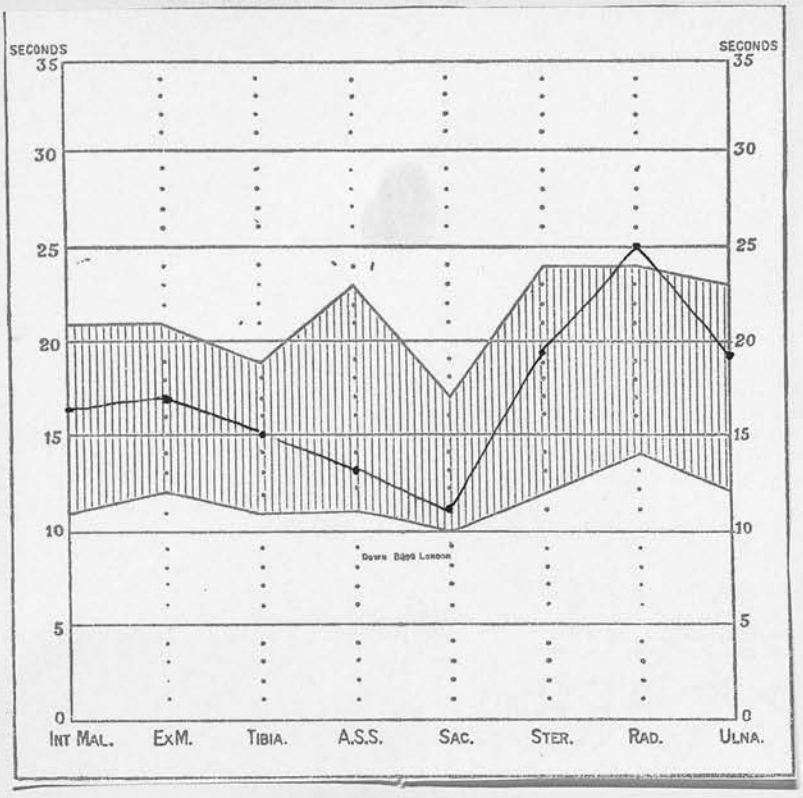
XXXVII.



MITRAL STENOSIS

Raymond HORNER (18)
20, Percy Street,
Fartown.

Mitral Stenosis.



MITRAL STENOSIS

Raymond HORNER (18)
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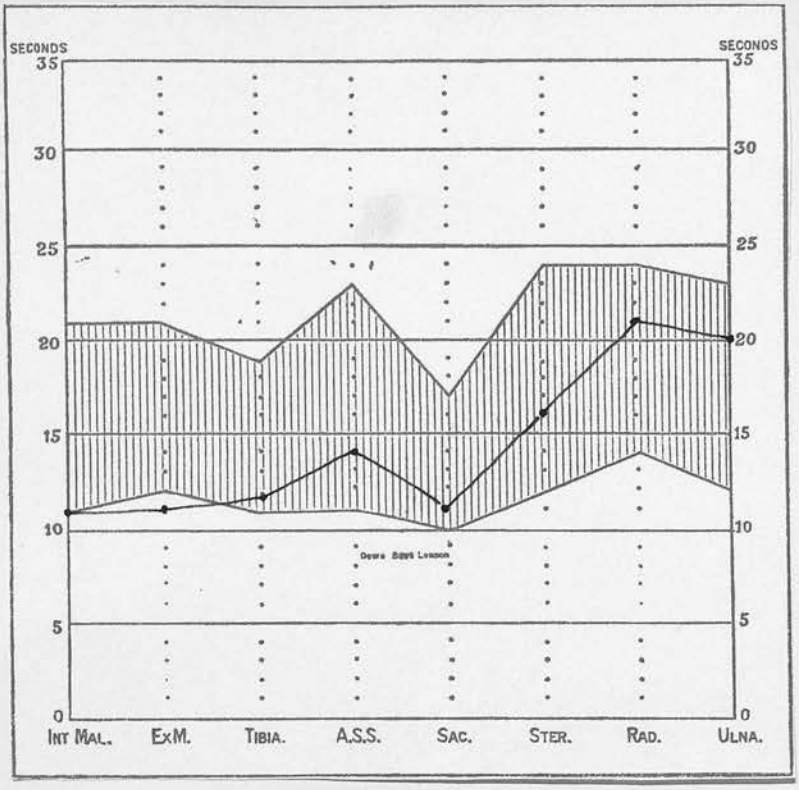
Mitral Stenosis.



DEBILITY

Lilian MANCHESTER (20)
26, Greensend Road,
Meltham.

General debility, loss of weight.

Vomiting daily for months.

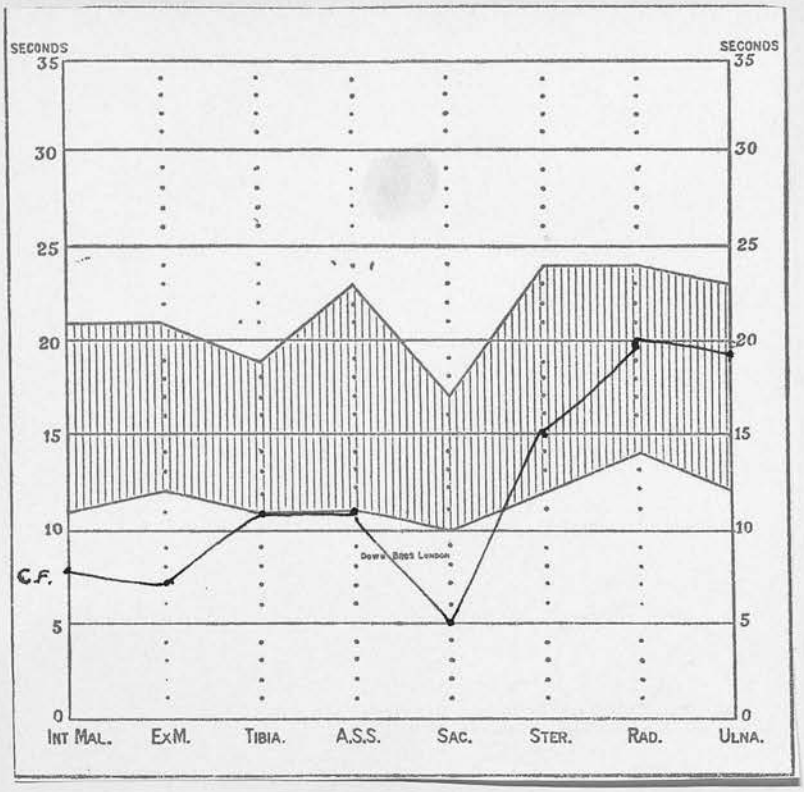
Severe shock November 1934.

Thin, dry, skin; no subcutaneous fat.
No tumour felt.

Offensive breath.

Wt. 4st. 11½ lbs.

Heart)
Lungs) N.A.D.
Blood Count)



NEURASTHENIA

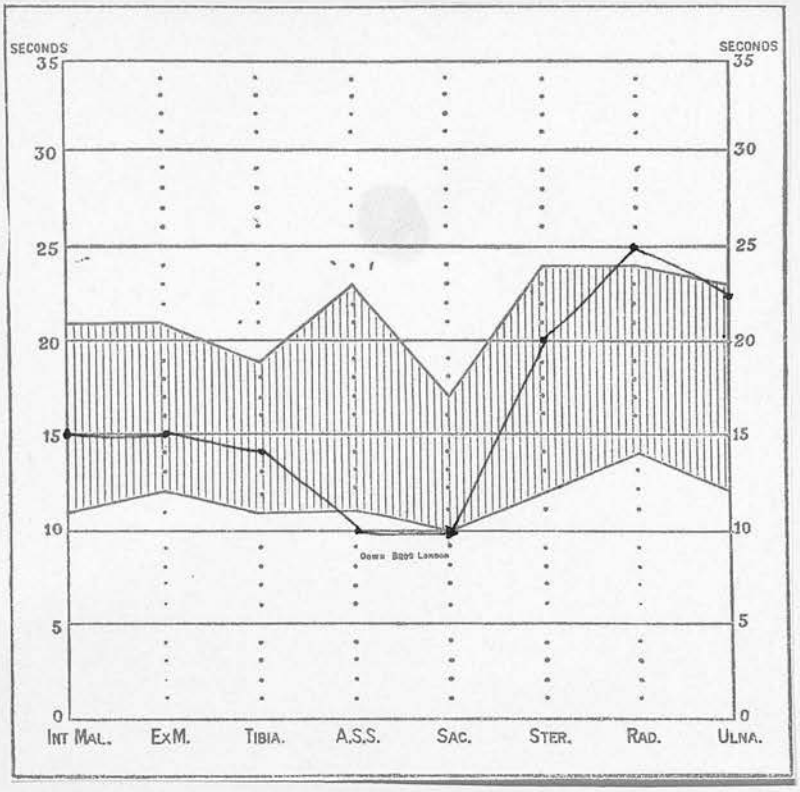
Edwin PARKIN,
13, Larch Avenue,
Thongsbridge.

History of headaches, breath catching, choking, tremblings, weakness.

Works in an asylum.

On physical examination

N.A.D. except B.P. $\frac{175}{100}$



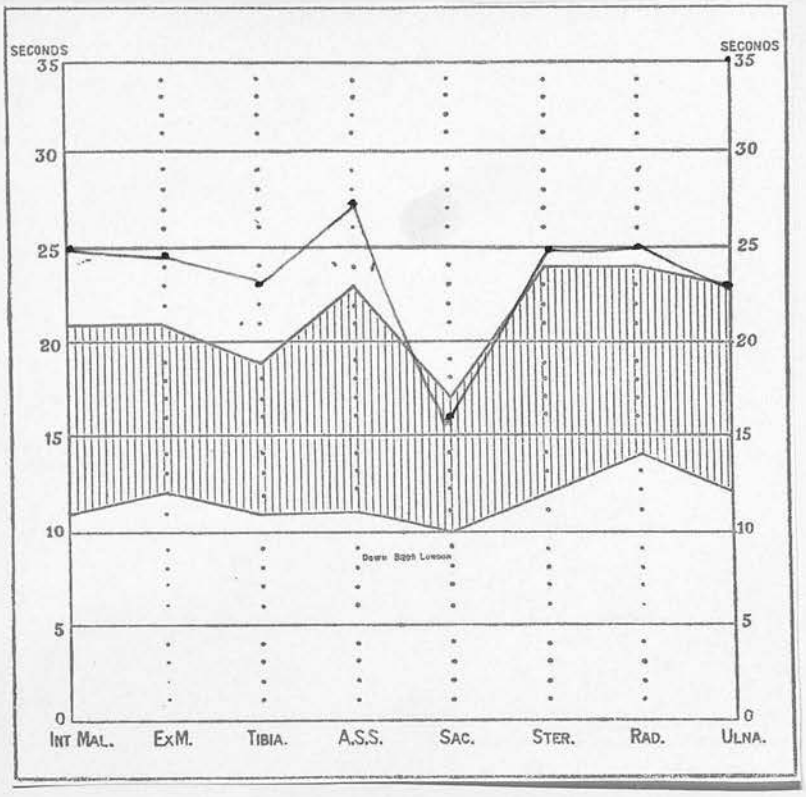
G.C. ARTHRITIS

Frank ROBINSON (31)
69, Victory Avenue,
Paddock.

Gonococcal Arthritis. Left elbow, left wrist and right side of neck principally affected.
Middle finger right hand.
Ring finger left hand.
Had left wrist drop about 9 months ago.

Gonococcal complement. ——

Fixation test, - positive.



HYPERTHYROIDISM

Mildred SHAW (32)
26, Mulberry Street,
Moldgreen.

Commenced five months ago with sudden exophthalmos. Insomnia, excitability.

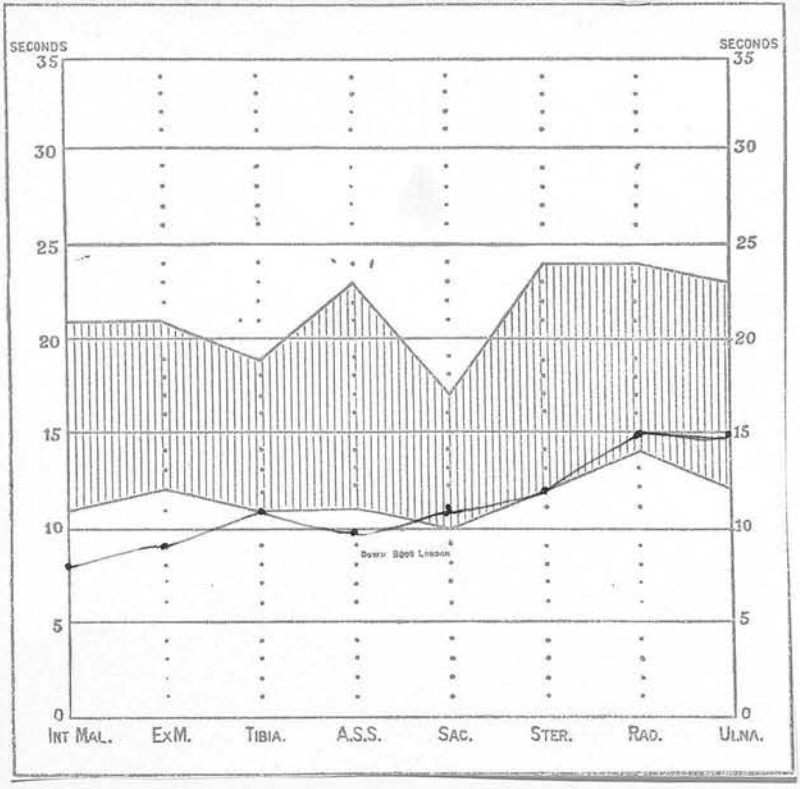
Moist skin, flushes easily. Tremor, more marked in right hand.

Exophthalmos, with eye signs.
Apex beat diffuse, displaced down and out 6" from midline.

Pulse 130, B.P. $\frac{155}{88}$

Has had asthma.

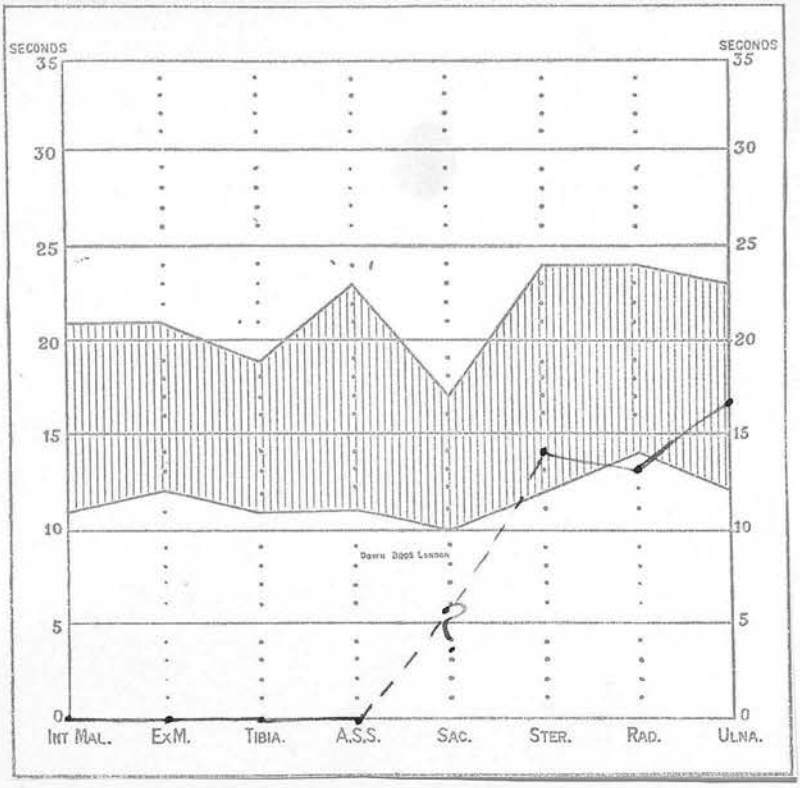
OLD AGE, FIVE CASES.



OLD AGE

Sarah Jane BAMFORTH (77)
Park View,
Stainland.

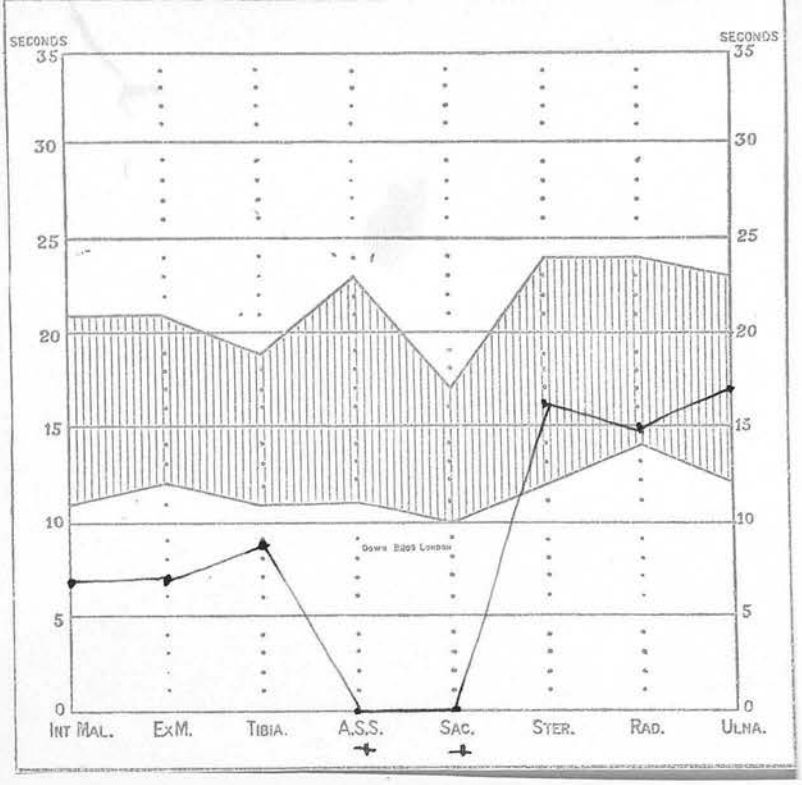
Cholecystitis.



OLD AGE

Mrs Emma BUCKLEY (84)
45, Clough Road,
Golcar.

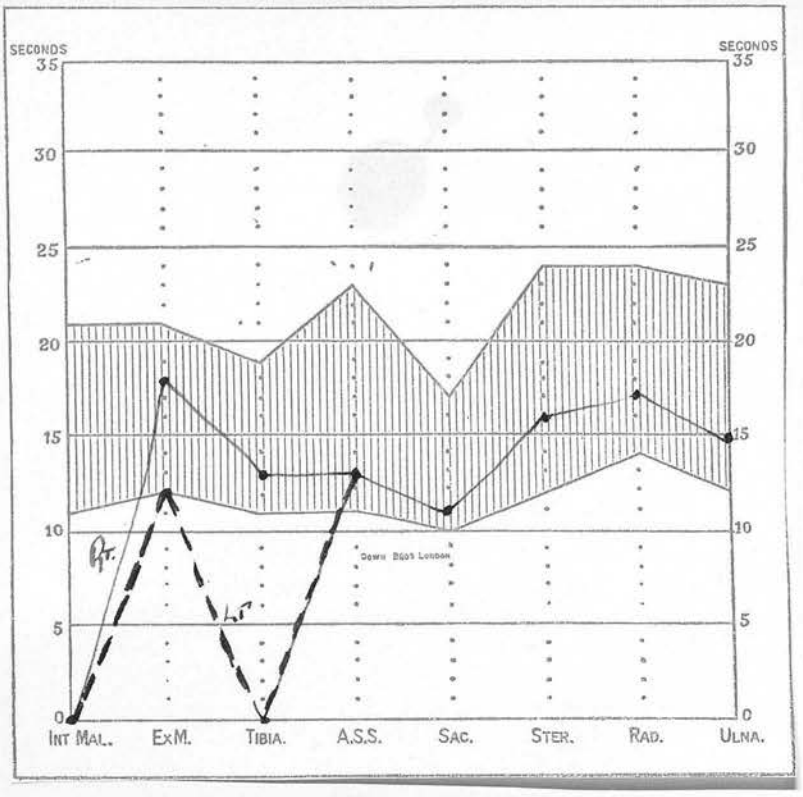
Fractured left femur (neck).



OLD AGE

Tom HARRISON (71)
23, Bankfield Road,
Huddersfield.

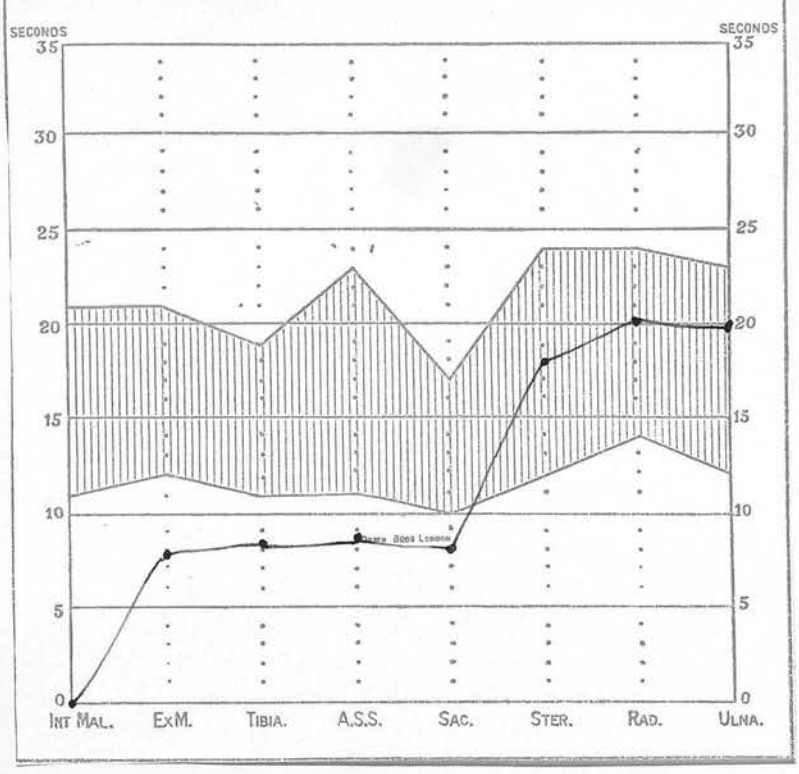
Eczema.



OLD AGE

Elijah HELLEWELL (71)
The Clough,
Greenside,
Thurstonland.

Cataract.

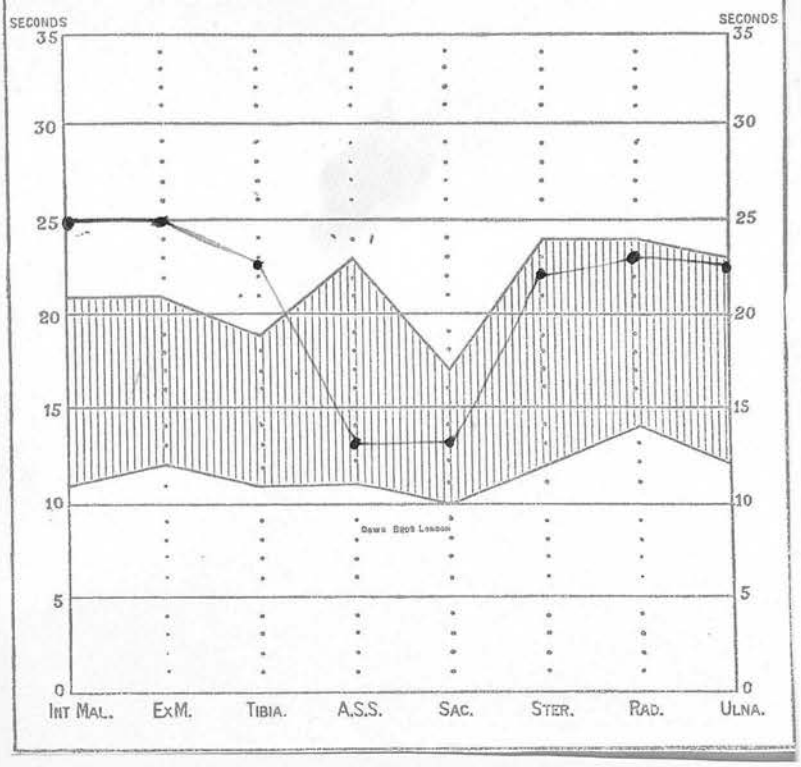


OLD AGE

Agnes HEPWORTH (75)
94, Broomfield Road,
Huddersfield.

Fracture of neck of right femur.

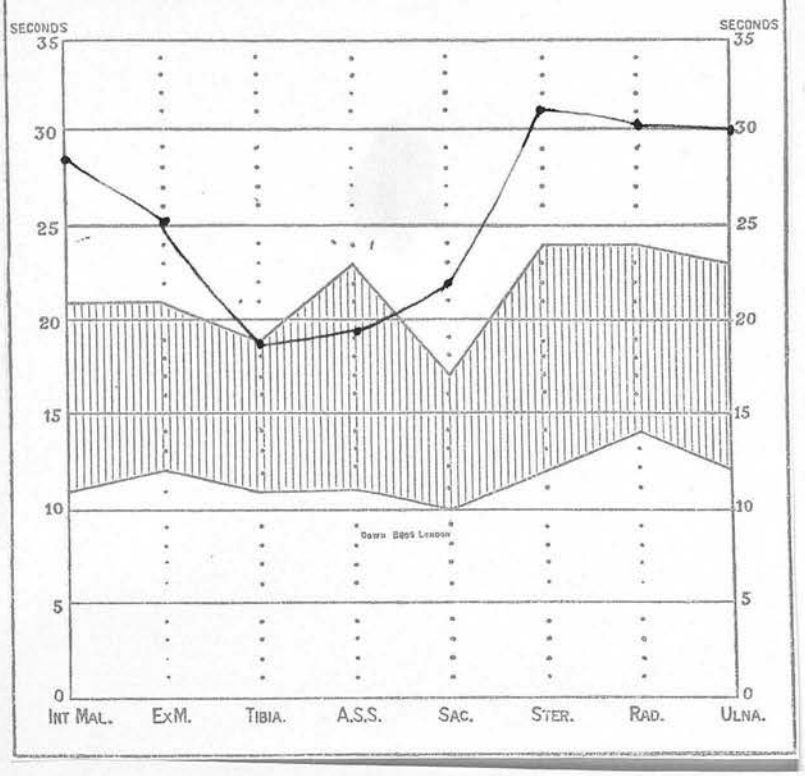
BLIND INDIVIDUALS, FIVE CASES.



BLIND

Thomas CLARK (21)
Broad Oak Farm,
Linthwaite.

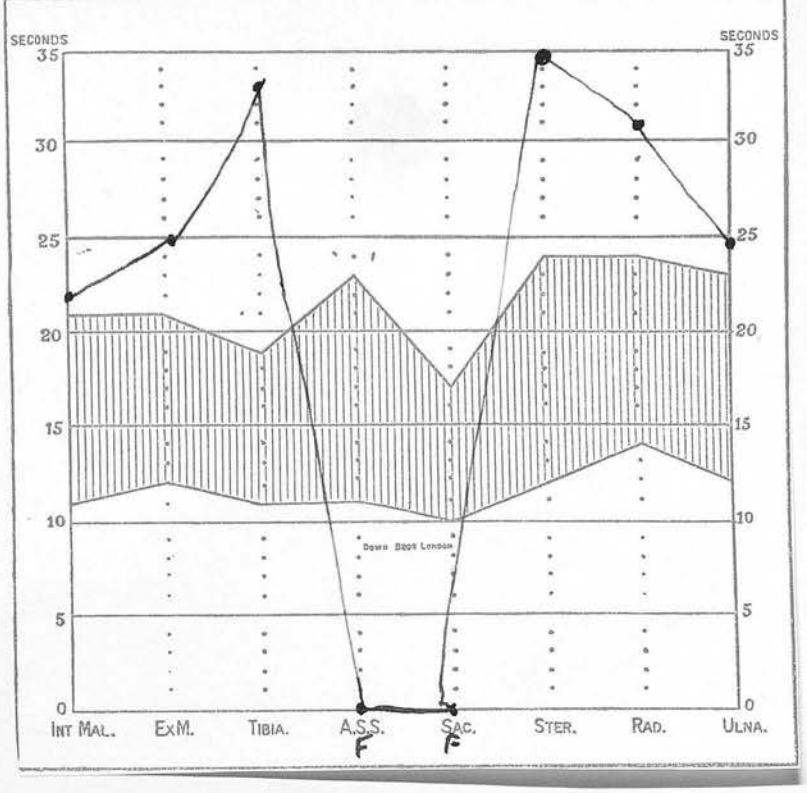
Blind for 17 years, the result of measles and meningitis.



BLIND

Winifred DYSON (21)
42, Poplar Street,
Huddersfield.

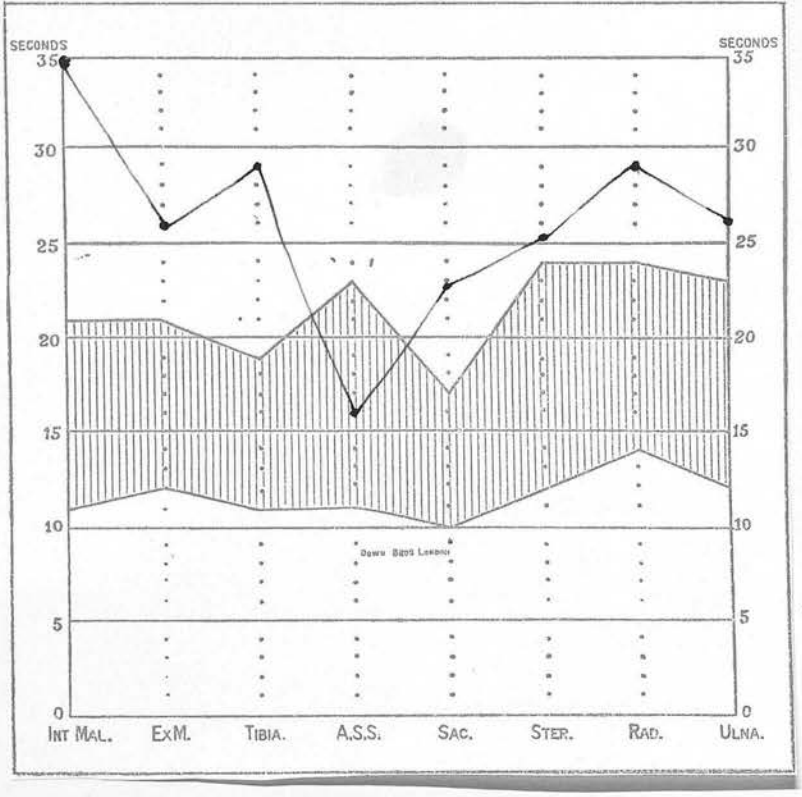
Blind since 6 years of age.



BLIND

Lucy POPPLETON (41)
90, Rashcliffe Hill,
Huddersfield.

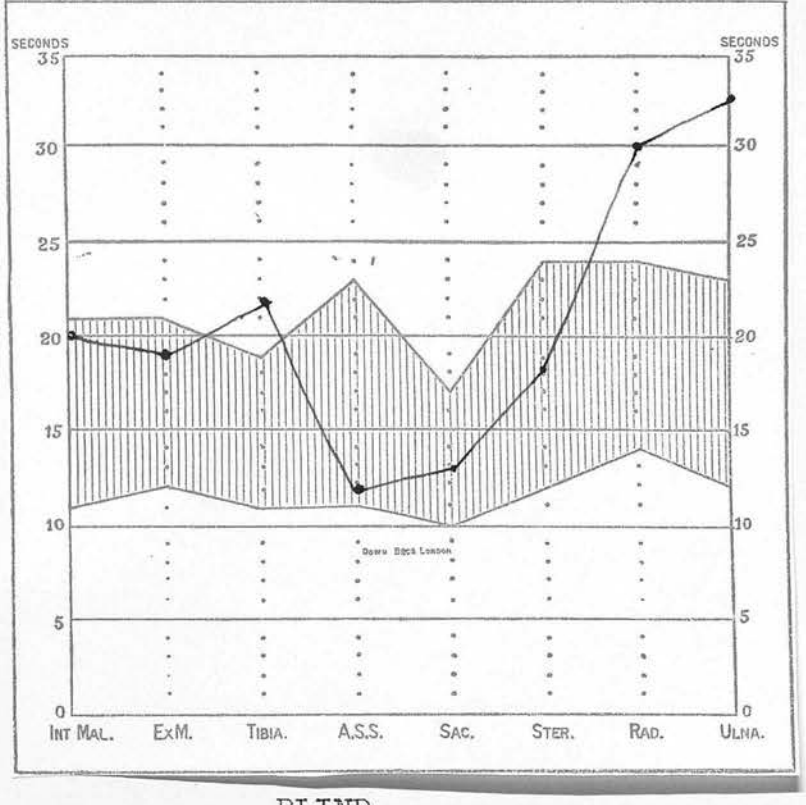
Blind for 39 years.



BLIND

Richard TURNER (30)
332, Blackmoorfoot Road,
Crosland Moor.

Blind for 22 years.

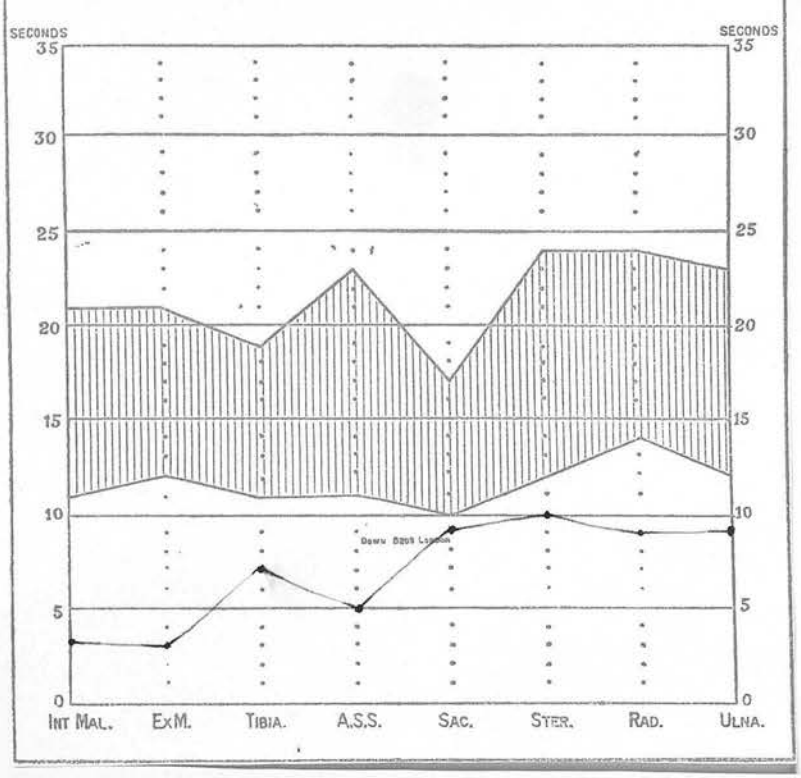


BLIND

Violet WISDOM,
3, Clara Street,
Fartown.

Blind since birth.

SYPHILITIC AORTITIS, FIVE CASES.



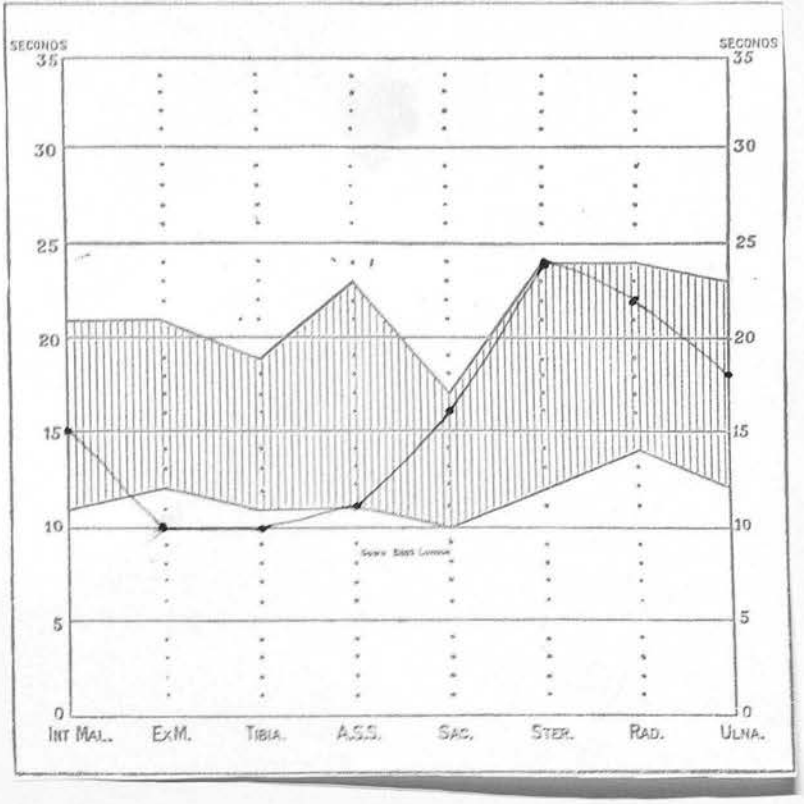
SYPHILITIC AORTITIS

Thomas BLUNDELL (67)
4, Sunny View,
Deighton.

Aortic incompetence. Persistent headache. Feeble old man.

Blood W.R. strongly positive

C.S.F. Negative findings.



SYPHILITIC AORTITIS

Harold BOOTH (34)
6, York Place,
Huddersfield.

Felt pulsations in chest for 5 years, after course of weight-lifting.

Influenza 16 days before admission.

Heart Double aortic, pulmonary and mitral murmers, heard best at aortic area.

Cor bovinum

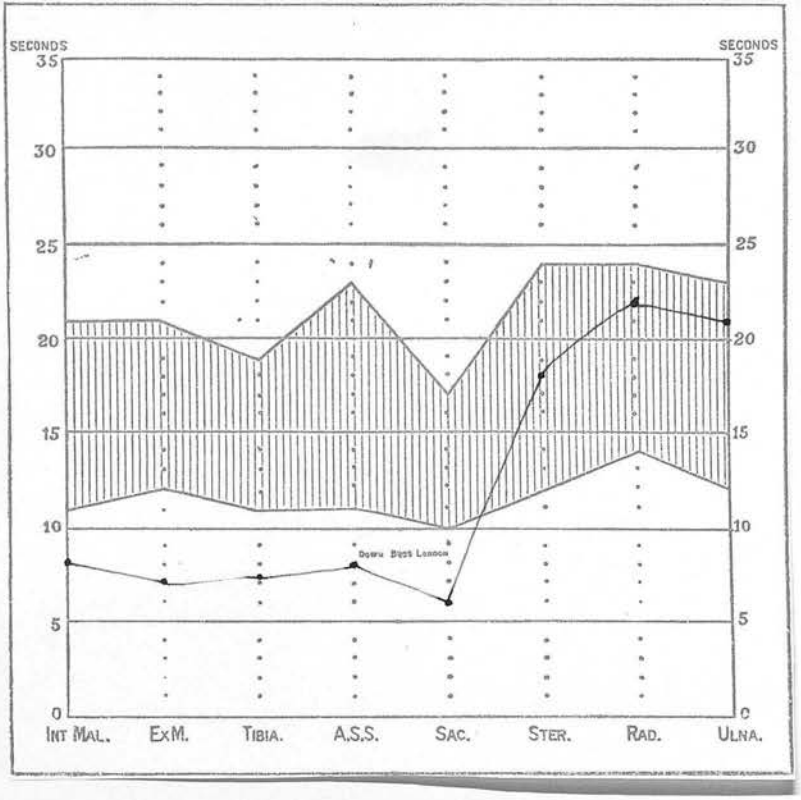
Corrigans pulse. B.P. $\frac{210}{?}$

Heavy drinker and smoker.

Fundi Right side choroiditis with pulsatile arteroles.

(Fit for Navy 1917)

W.R. positive.



SYPHILITIC AORTITIS

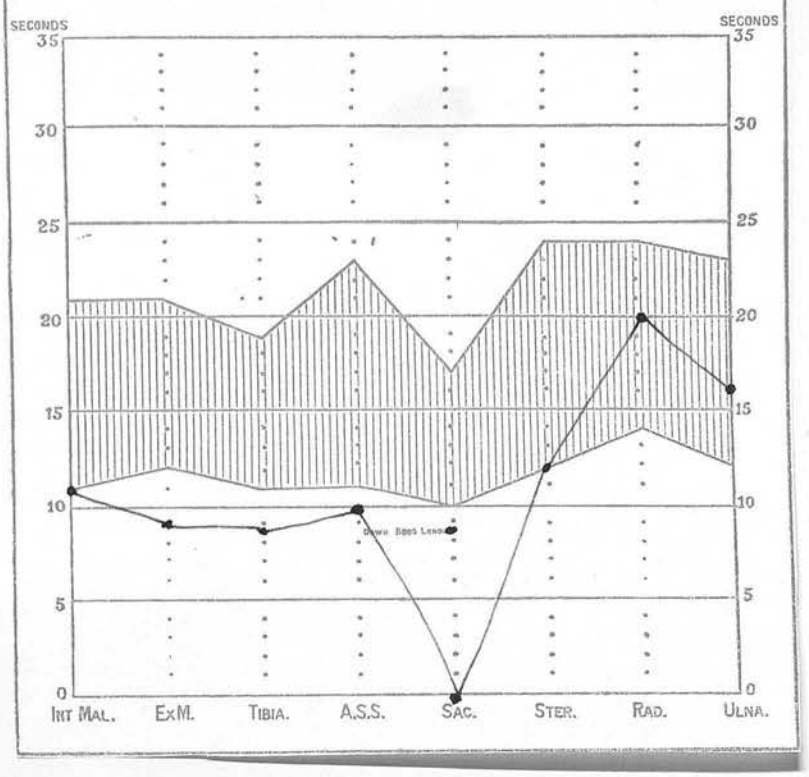
Ernest EASTWOOD (61)
15, Lyndale Avenue,
Birkby.

Embolism of left superior temporal artery fortnight before admission.

Heart Double mitral and aortic diastolic murmers.

Heart enlarged.

B.P. 145/70 W.R. Positive.



SYPHILITIC AORTITIS

Henry HALL (66)
236, Lockwood Road,
Lockwood.

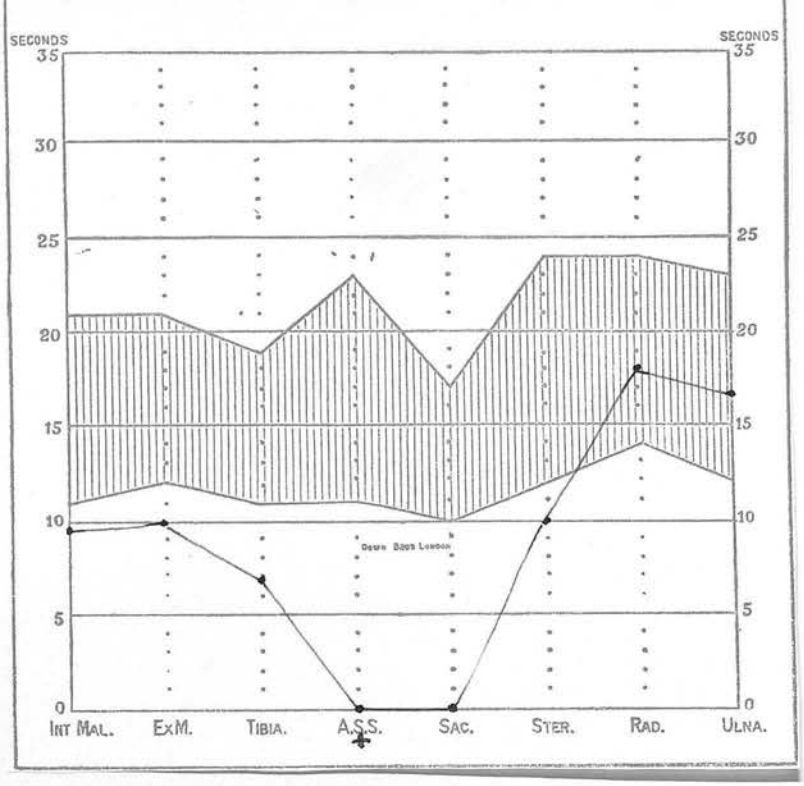
Collapsed in street.

Heart Enormously hypertrophied heart.
Double mitral and aortic murmurs.

W.R. Strongly positive 1 - 32.

Screeising and X-Ray. Large pulsatile swelling to right and left of mid-line in region of ascending aorta.

C.S.F - N.A.D.



SYPHILITIC AORTITIS

Harry PICKERSGILL (52)
29, Hillhouse Lane,
Huddersfield.

Pain in stomach for 4-5 years. Comes on after meals. Vomiting and medicine relieves pain. Dizziness and insomnia, $\frac{-}{c}$ loss of weight.

Breathlessness, oedema of feet. Fainting attacks. Aortic and mitral double murmurs. Greatly enlarged left ventricle.

Pulse, Corrigans. B.P. $\frac{195}{65}$

Deafness. Mist ? in front of eyes.

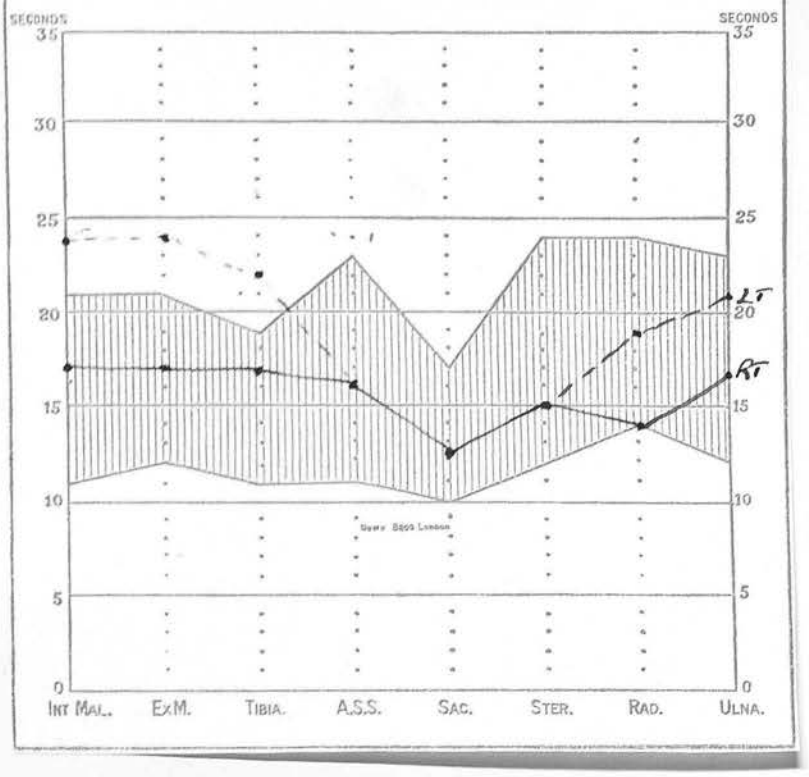
X-Ray. Spasm of middle of stomach, but no definite evidence of organic lesion.

Heart generally enlarged.

F.T.M. Achlorhydria, + + mucus.

W.R. Blood positive.

POST-ENCEPHALITIC PARKINSONIAN, FIVE CASES.

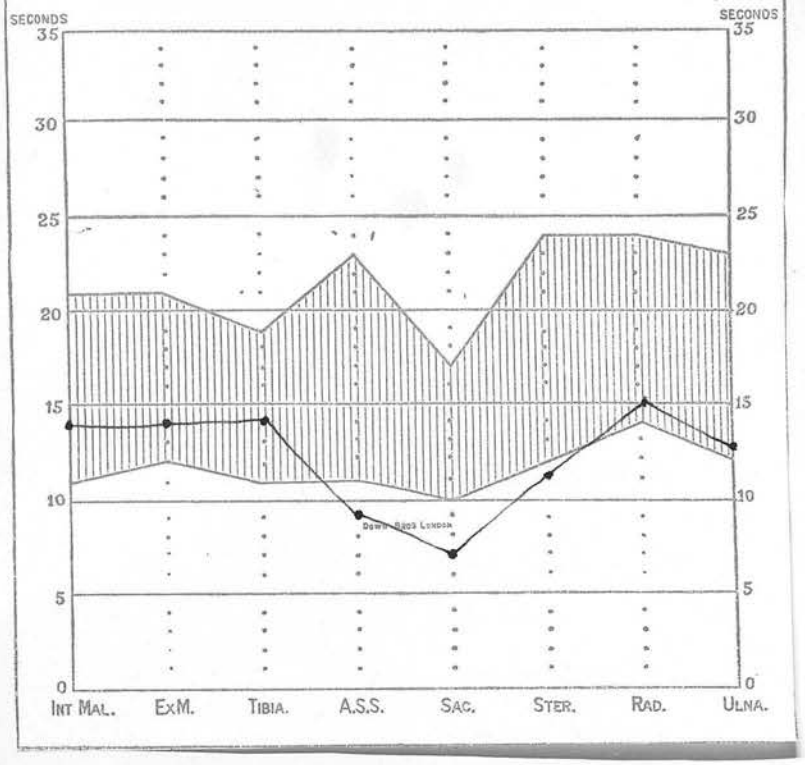


POST. ENCEPHALITIC PARKINSONISM

Stanley CLAYTON. (29)
Dogley Lane,
Fenay Bridge.

Typical parkinsonian facies and gait.

Right side the worst.



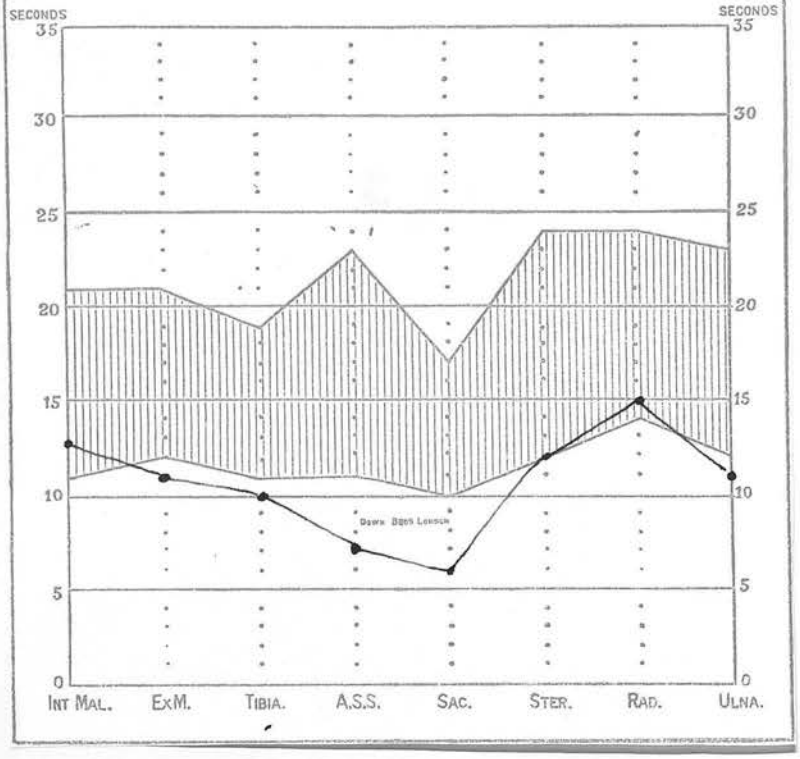
POST-ENCEPHALITIC PARKINSONISM.

Frank HOLLAND (42)
3, Malvern Road,
Newsome.

Ptosis left upper lid, diplopia, unequal pupils which react to light and accomodation, two years ago.

Brain storms.

Now typical parkinsonian facies and gait.

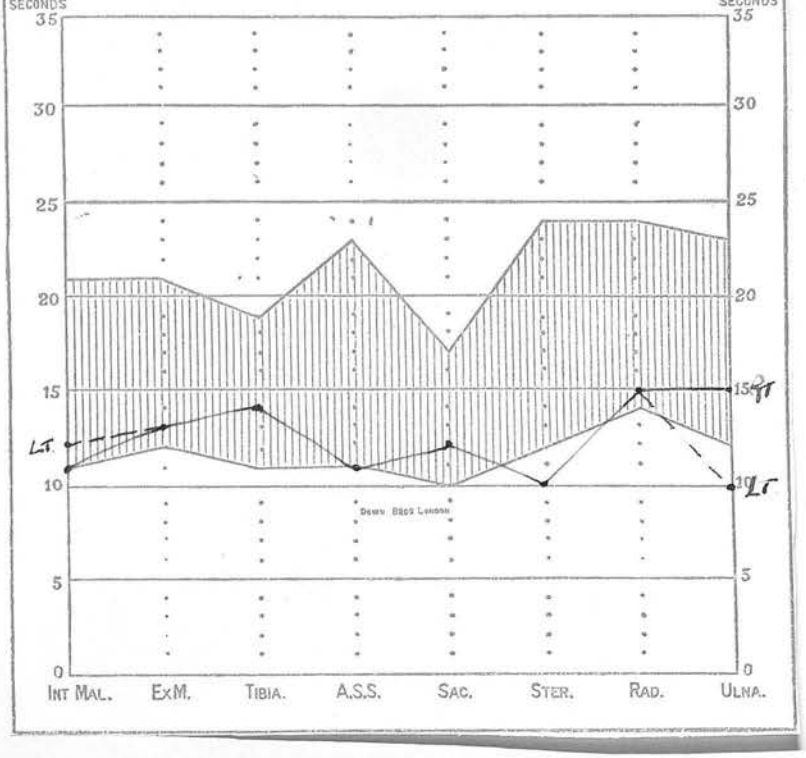


POST- ENCEPHALITIC PARKINSONISMS

Annie LARCOMBE (46)
15, Shears Court,
Leeds Road, Huddersfield.

Eleven years ago had Encephalitis lethargica.

Now has advanced Parkinsonism. Speech writing and gait affected.



POST-ENCEPHALETIC PARKINSONISM

William SHEARD (56)
18, Clough Road,
Birkby.

Scarlet Fever in December 1933.

Coarse tremor, more marked in left arm.

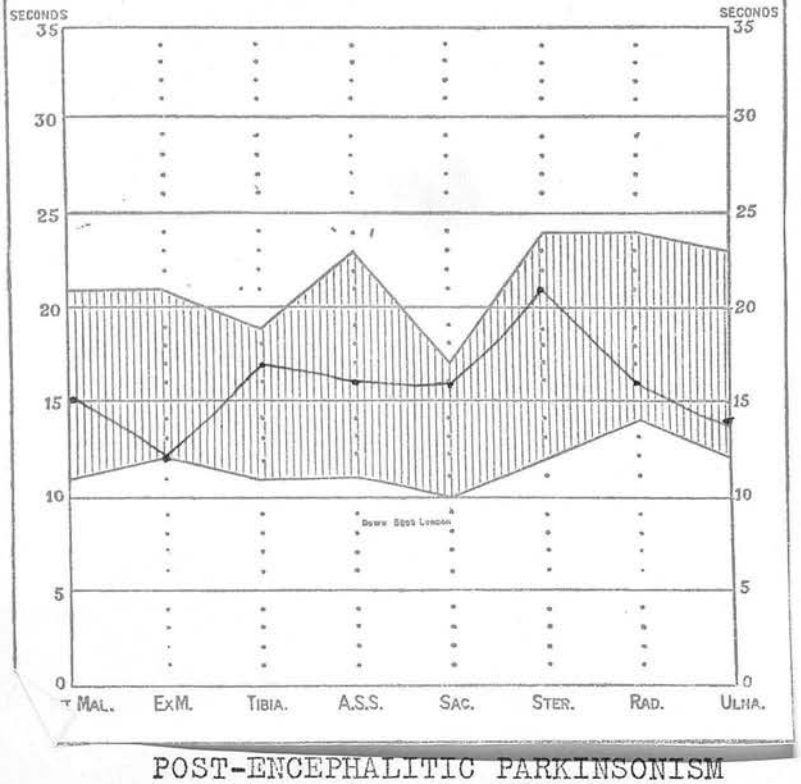
Stiffness and cog-wheel rigidity.

All reflexes present.

No clonus.

Plantar response flexor.

No sensory changes.



POST-ENCEPHALITIC PARKINSONISM

Annie TATTERSALL (29)
69, Swallow Lane,
Golcar.

Symptoms began $2\frac{1}{2}$ years ago (after confinement).

Tremor of hands, tongue excessive salivation, fixed expression, Parkinsonian gait, impassive features.

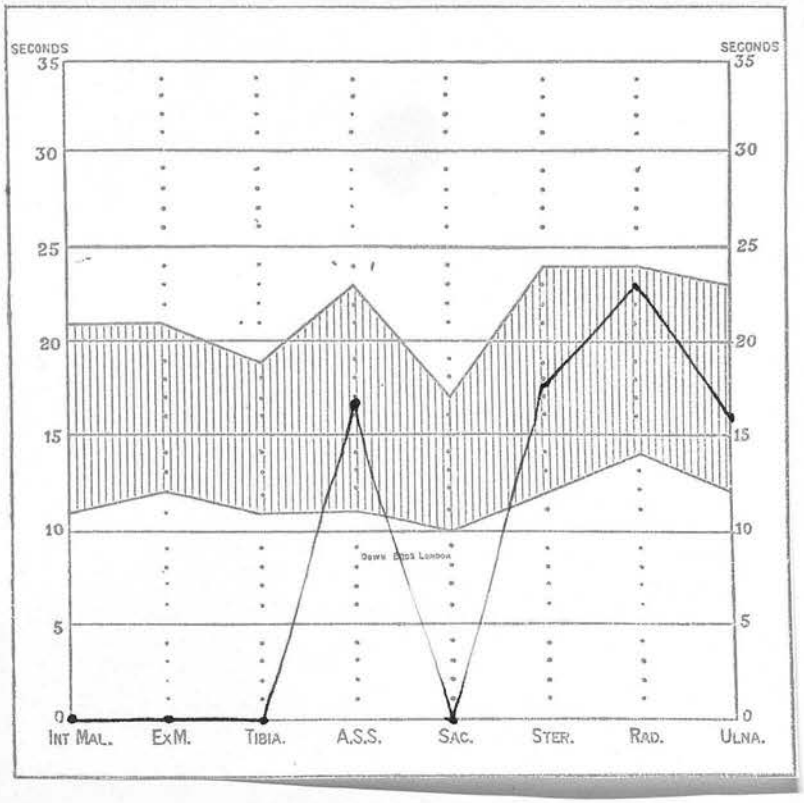
Absences of winking.

Rapid slurring speech, cogwheel spastricity.

Memory bad.

Tacchycardia.

TABES DORSALIS, FIVE CASES.

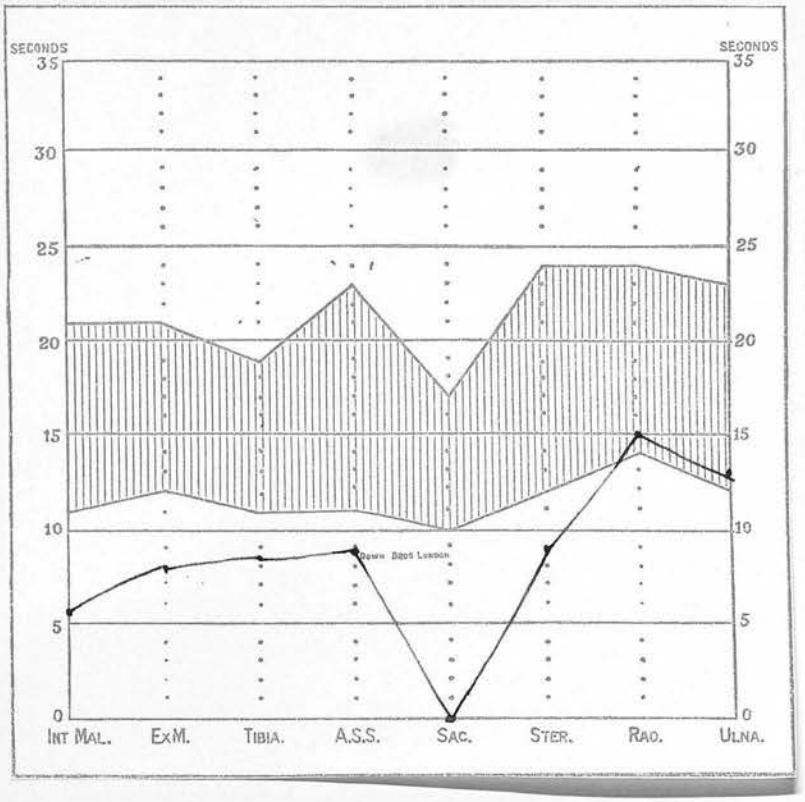


TABES.

No. 3605 (49) V.D. Clinic.

Typical Tabetic, with Rhombergism, ataxia, absent knee-jerks, lightning pains, anaesthesia of both legs.

Occasionally has convulsions.

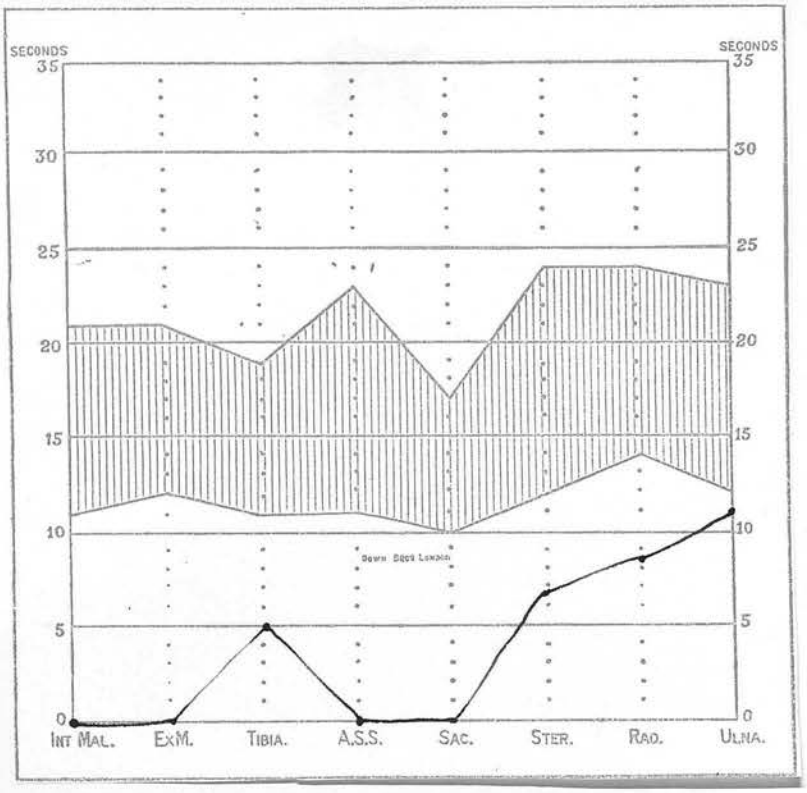


Tabes.

No. 3692. V.D. clinic (35)

Typical tabetic, with Argyll-Robertson pupils. Rhombergisms, etc.

Absent knee-jerks.



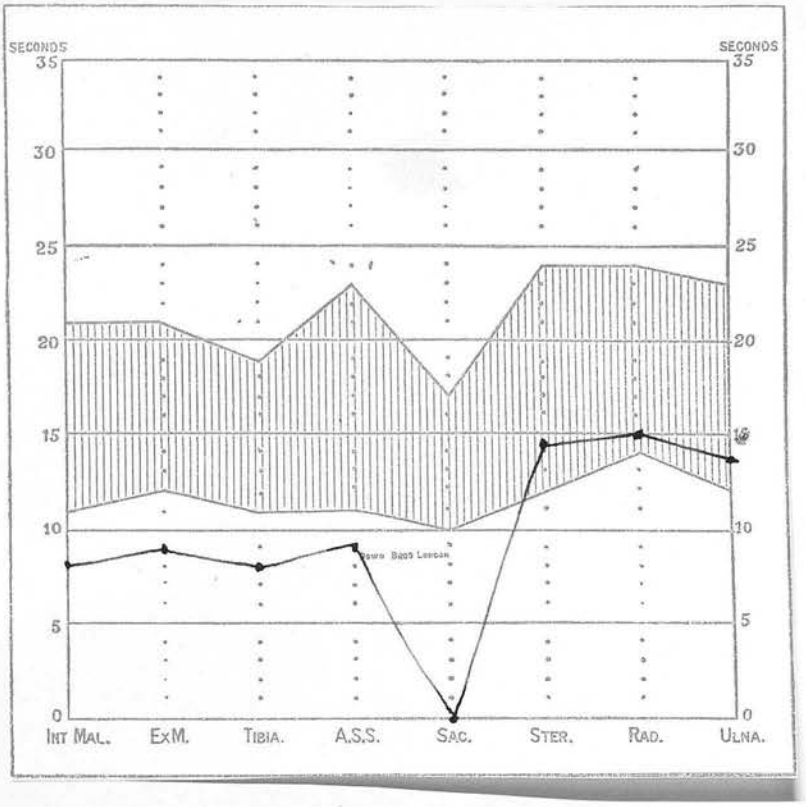
TABES

No 4429 (63) V.D. Clinic.

Typical Locomotor ataxia.

Pin-point pupils, etc.

Gumma right leg.

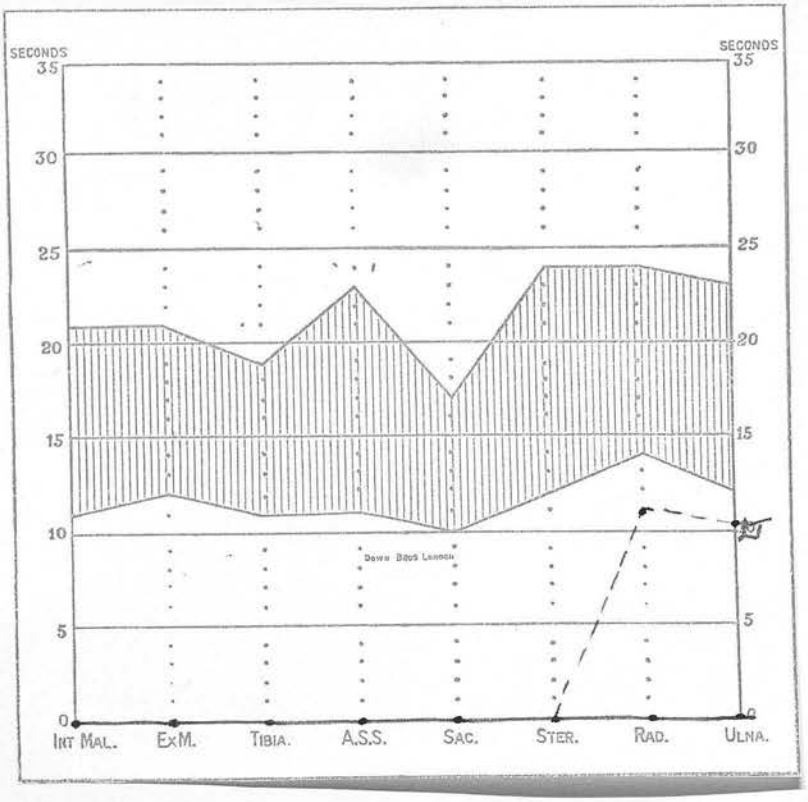


TABES

No. 4454 (59) V.D. Clinic.

Typical tabes Knee Jerks absent.

Argyll-Robertson pupils, Rhombergisms, etc.



TABES.

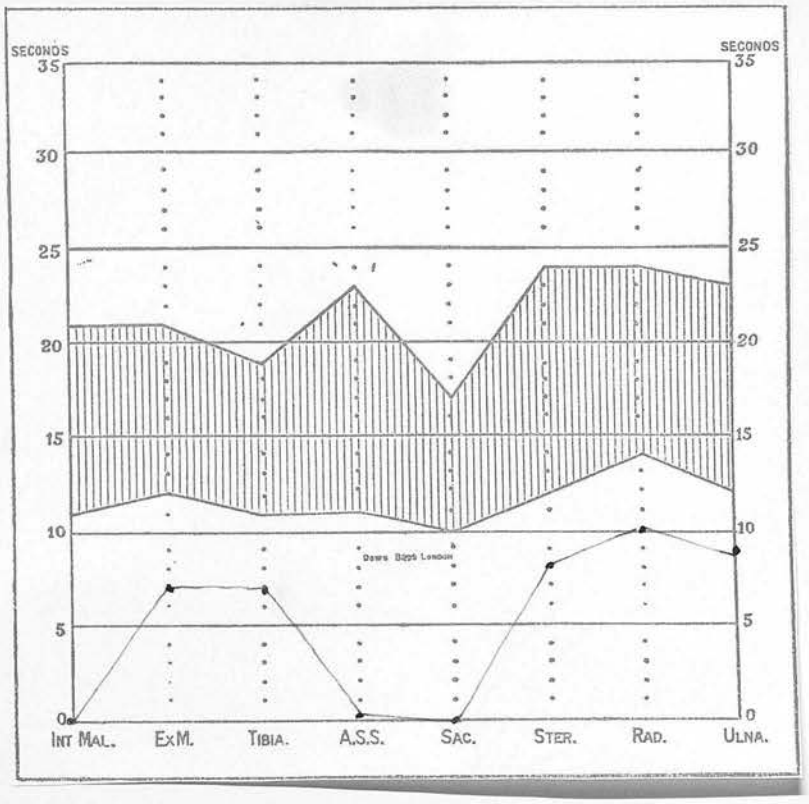
John STENSON, (43)
261, Long Lane,
Dalton.

Known to have tabes for 15 years.
Ataxia, Argyll-Robertson pupils,
absent reflexes.

Has been under treatment with malaria.

Caries of scaphoid of right foot.

DISSEMINATED SCLEROSIS, FIVE CASES.



D.S.

Lucy BAMFORTH
11, Sandwell Street,
Hill Top, Slaithwaite.

Loss of power in legs, numb feeling in hands.

Sees double after using eyes for some time.

Cranial nerves normal. No nystagmus.

Power in left arm worse than right.

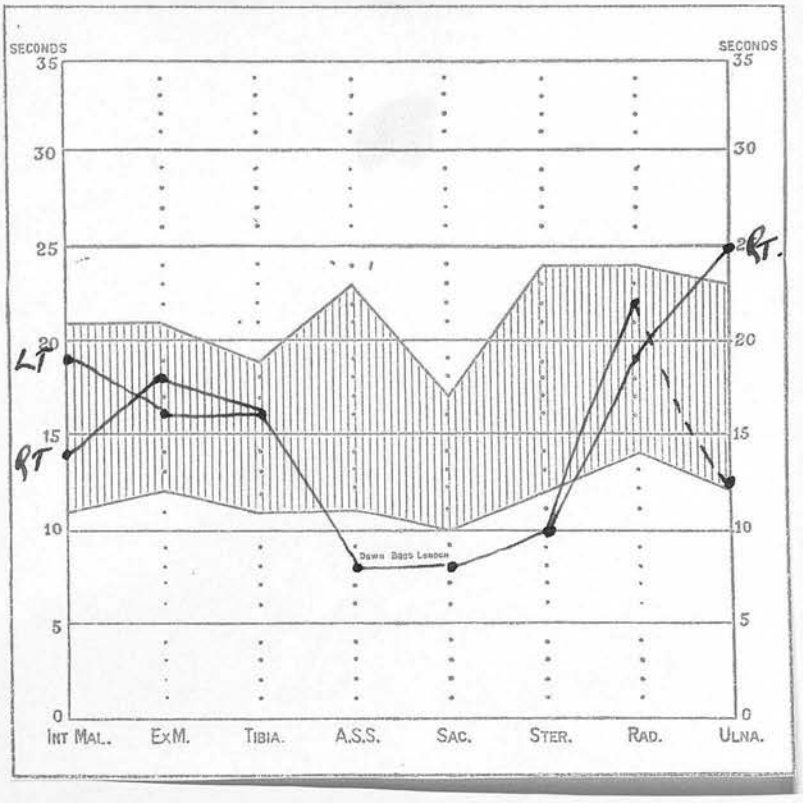
Tendon reflexes of arms normal.

Abdominal reflexes absent.

Legs Left spastic, right normal
Tendon reflexes brisk, left more than right. Plantar response extensor. Ankle clonus on left.

No sensory loss, except for vibration.

Fundi normal.



D.S.

Mary BURTON (29)
20, Kilners Buildings,
Longroyd Bridge.

Admitted with paresis of right superior rectus and right levator superior causing diplopia, for 14 days. For a similar period she has had difficulty in walking.

Also cannot straighten fingers in cold weather.

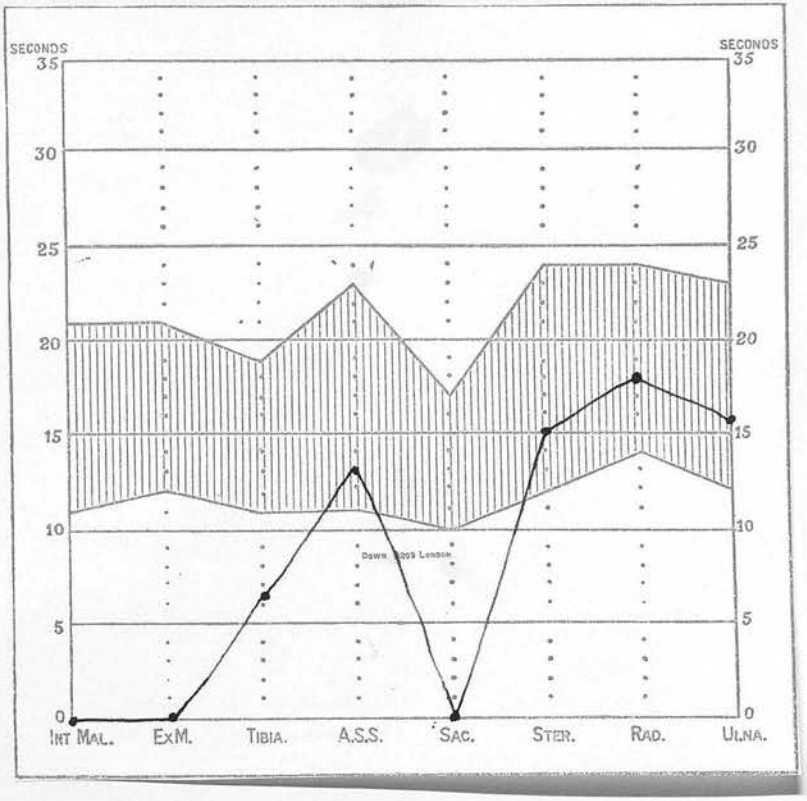
C.N.S. All deep reflexes + + especially knee jerks. Abdominals brisk.

Plantar reflexes flexor.
Nystagmus to left.

Muscular power good, no inco-ordination of limbs.

No sensory changes, no trouble with bowels or bladder.

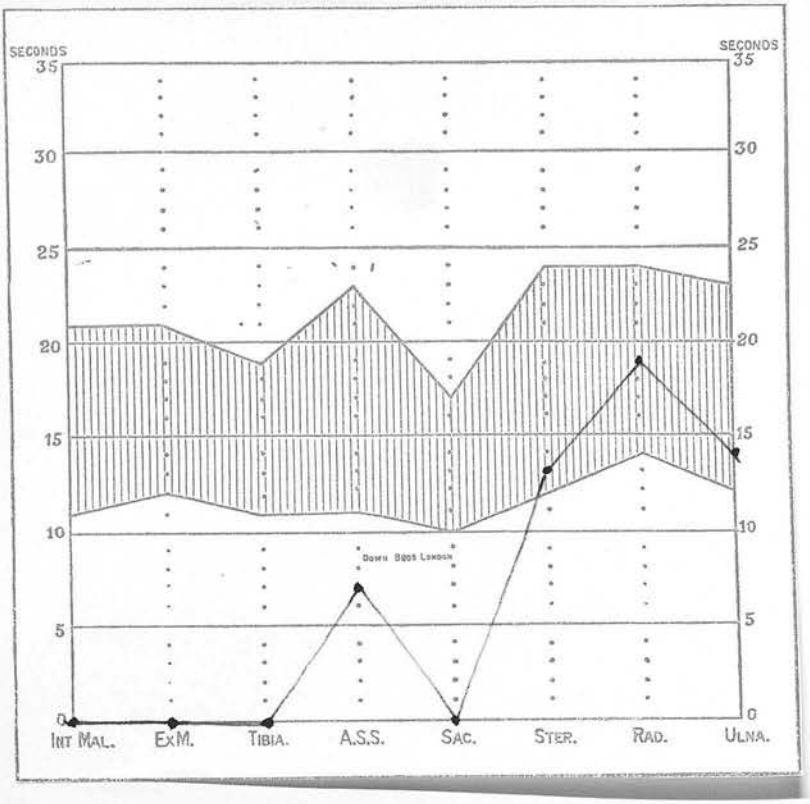
C.N.S.)
) N.A.D.
W.R.)



D.S.

Albert MC DOUGALL (58)
75, Cliff End Road,
Longwood.

Old case of disseminated sclerosis with marked spasticity, referred from Manor House Hospital.



D.S.

Elsie WALKER (37)
16, Netherclose,
Dalton.

Diplopia to right began 10 weeks ago, with cold feeling down face and much lassitude.

Numbness, coldness and cramp in both legs. Also difficulty in walking, due to stiffness.

Pins and needles in fingers of left hand.

Vertigo tinnitus, headache

C.N.S. Ankle-jerks and knee jerks + +

Plantar reflexes flexor.

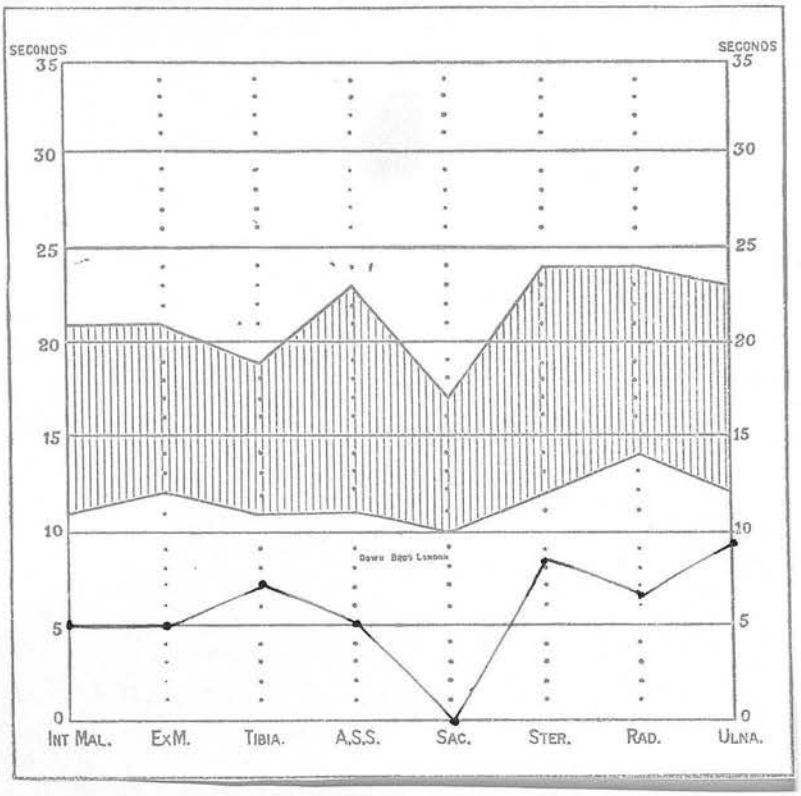
Absent abdominals.

No Clonus.

Stiffness in muscles, but no loss of power.

Only sensory changes is diminution of vibration.

C.S.F.)
W.R.) All normal.
Blood Count.)



D.S.

Leslie WHITEHEAD (31)
9, Broughton Road,
Marsden.

March ,1932 vertigo. Has diplopia.

Eyes Right int. rectus paresed, nystagmus up & to either side.

Reflexes. Abdominals absent, right ankle jerk absent, others + +. Cremasteric and dartos reflexes absent.

Mouth & tongue drawn over to left. Twitching of platysma on chin.

Right ear not as good as left. Falls to left on walking, or on being turned round in either direction.

Rhombergism. Plantar reflex extensor. Dysdiadokokinesia in left arm. No clonus.

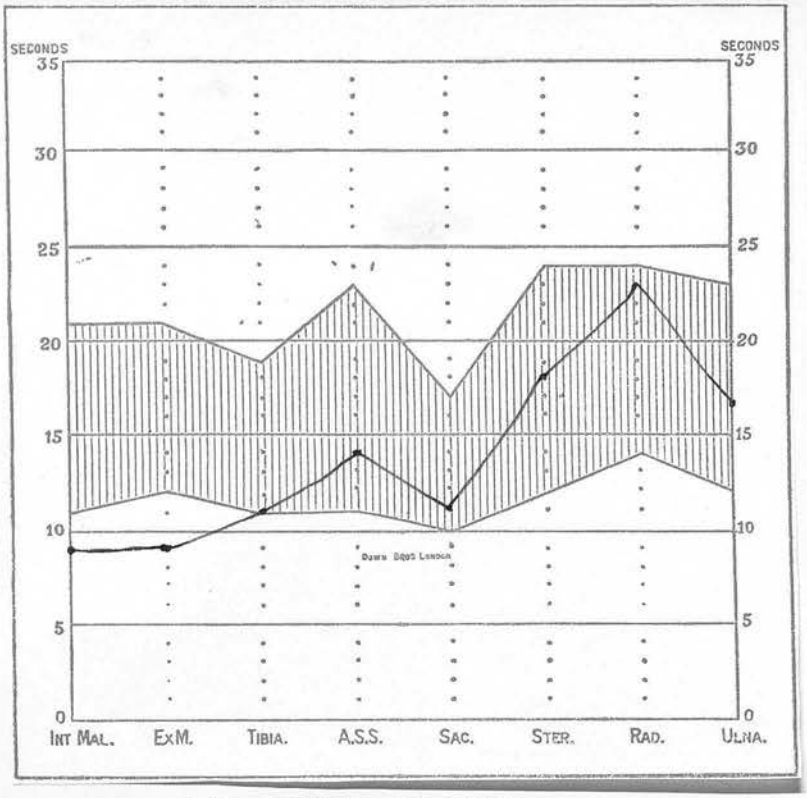
Muscular power. Normal in upper limit. Left leg normal, flexors of right ankle and knee very weak. Left thigh better developed than right.

Staccato speech.

Memory bad.

Fundi and C.S.F. normal. W.R. negative.

MICROCYTIC ANAEMIA, FIVE CASES.



MICROCYTIC ANAEMIA

Ben BROWN (60)
16, Dowker Street,
Milnsbridge.

Pain in precordia with palpitation.

Bad headache, worse on exertion and lying down.

Pallor, with lemon tinge.

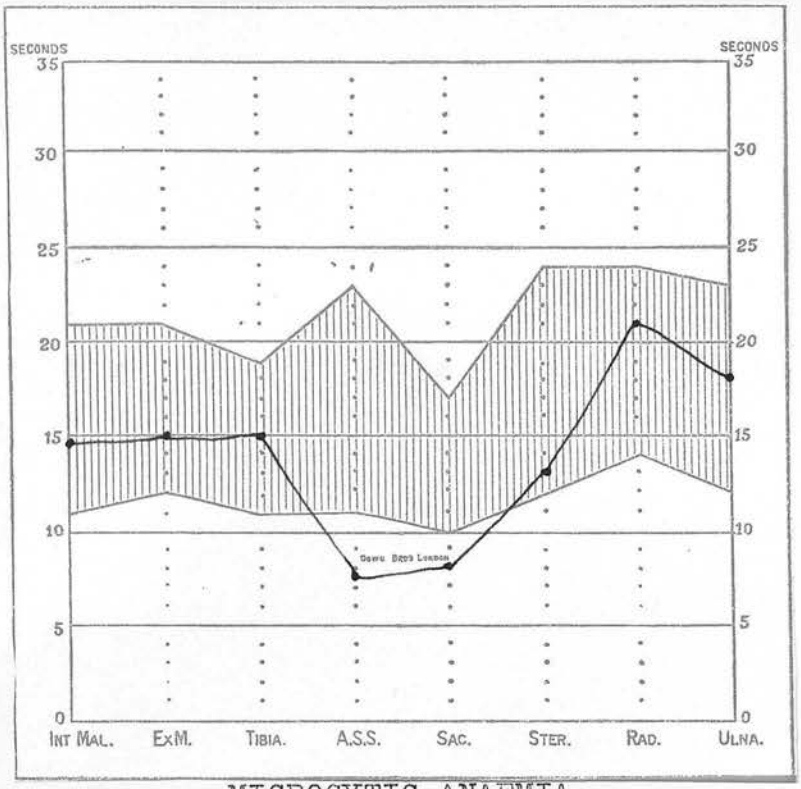
Haemic brints at base of heart.

Hb 25%. R.B.Cs 2,340,000. W.B.Cs 5,200
C.1 5.5

Polychromasia, punctate baso-philia and microcytosis.

F.T.M. Total achlorhydria.

X-Ray. Some evidence of duodenal adhesions. Duodenal cup not satisfactorily filled.



MICROCYTIC ANAEMIA

Florence FINCH (50)
58, Highlands Avenue,
Almondbury.

Has been treated for 7 weeks for P.A.

Anaemia for 10 years.

Lungs Few rhonchi.

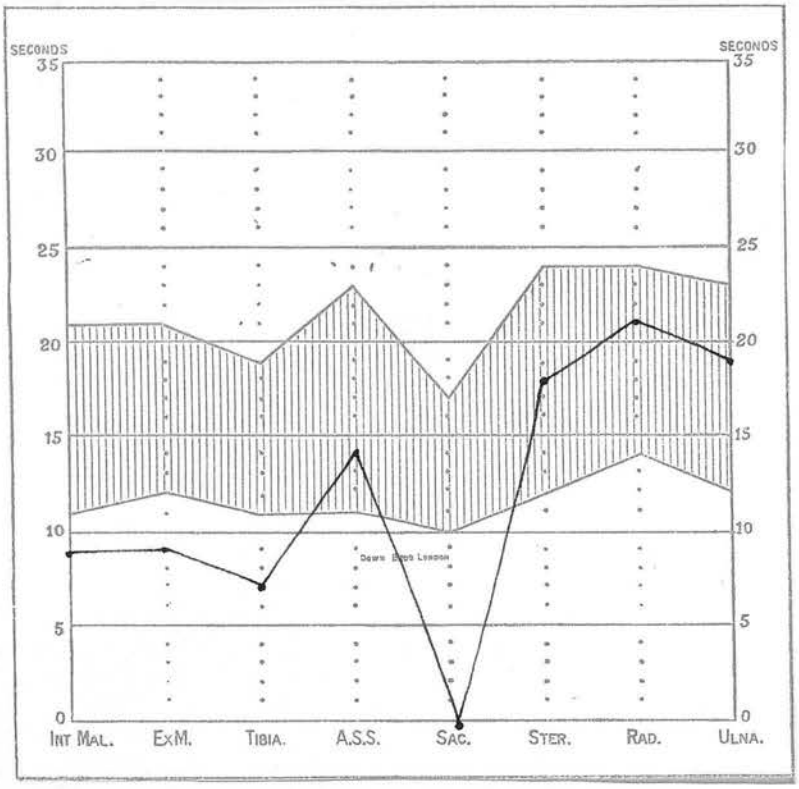
Heart Systotic brints in all areas, most marked in aortic.

Mild hypothyroidism.

Glossitis. Achlorhydria.

Hb 30%. R.B.Cs 3,060,000. C.I .4

Films show features of microcytic anaemia.



MICROCYTIC ANAEMIA

William Henry LOCKWOOD (59)
12, Spencer Street,
Skelmanthorpe.

History Typhoid Fever 1905.

For three months exhausted.

Lemon yellow pallor.

Tongue not sore.

Hb 30%. R.B.C's 2,460,000
W.B.Cs 7,000. C.I.6

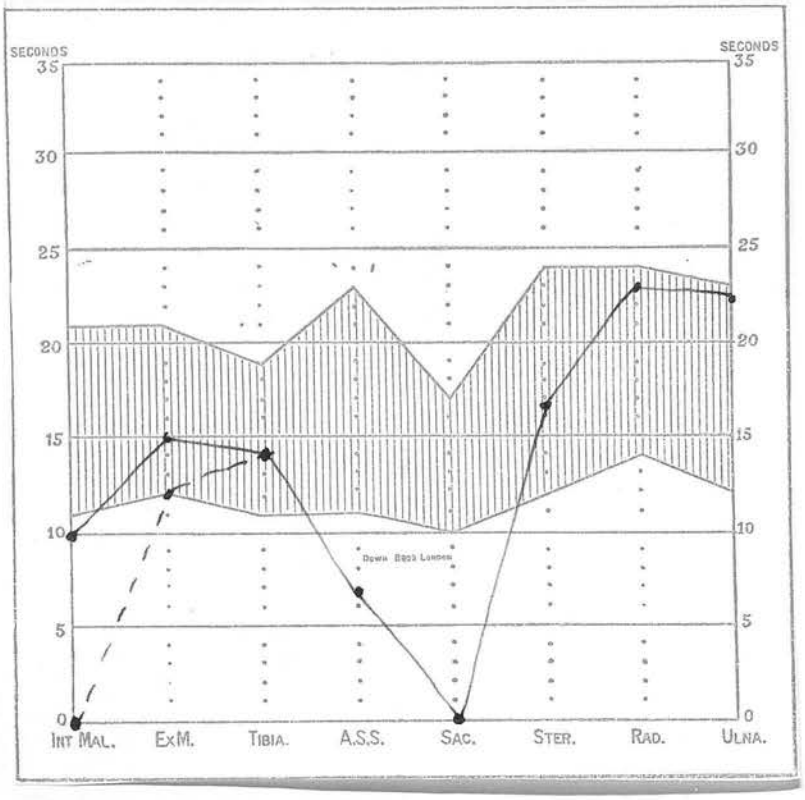
Microcytosis, but no picture of P.A.

Total achlorhydria, low total acidity, lactic acid + +

X-Ray Stomach N.A.D.

Stool Positive occult blood. Large pedunculated sloughing rectal polup. Excised by diathermy.

Second Exam: R.B.Cs 3,180,000. W.B.Cs, 5,200.
H.B. 42%. C.I 0·67



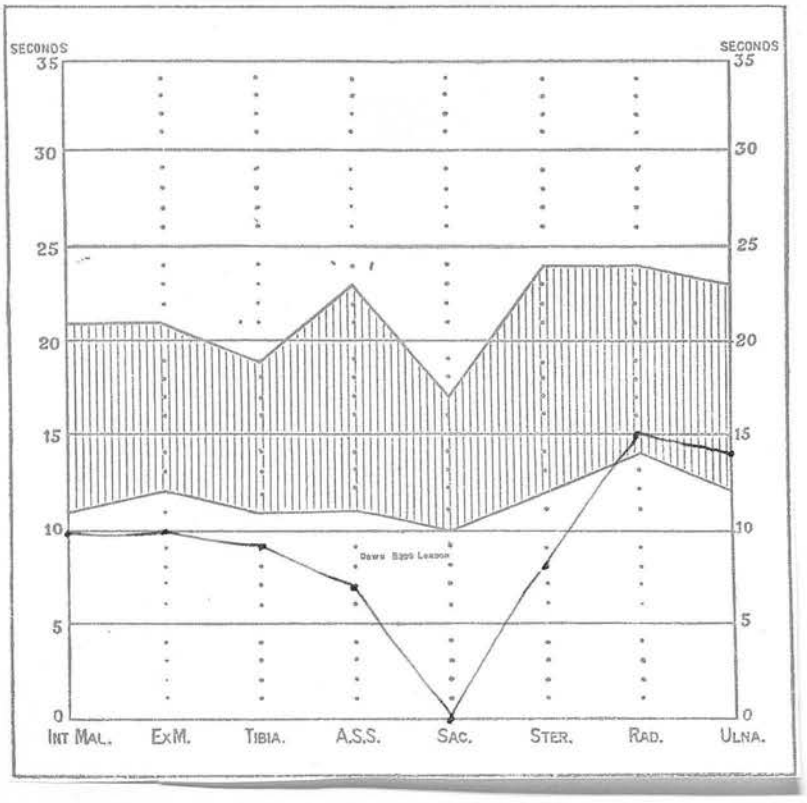
MICROCYTIC ANAEMIA

Bertha SHAW (52)
34, View Street,
Lockwood.

In hospital 1928 for 9 weeks, with diagnosis of P.A.

R.B.Cs	4,848,000
Hb	58%
C.I	0·6
W.B.Cs	5,600

Stained films show the R.B.cs very deficient in Hb Poikilocytosis and microcytosis.



MYCROCYTIC ANAEMIA

Kathleen TRANTER (44)
7, Ridge Road,
Middlestown.

Anaemic for many years.

General lassitude, and precordial pain on exertion.

R.B.Cs 4,490,000

Hb 28%

C.I .3

Dysphagia, total achlorhydria, spoon shaped finger nails.

Glossitis.

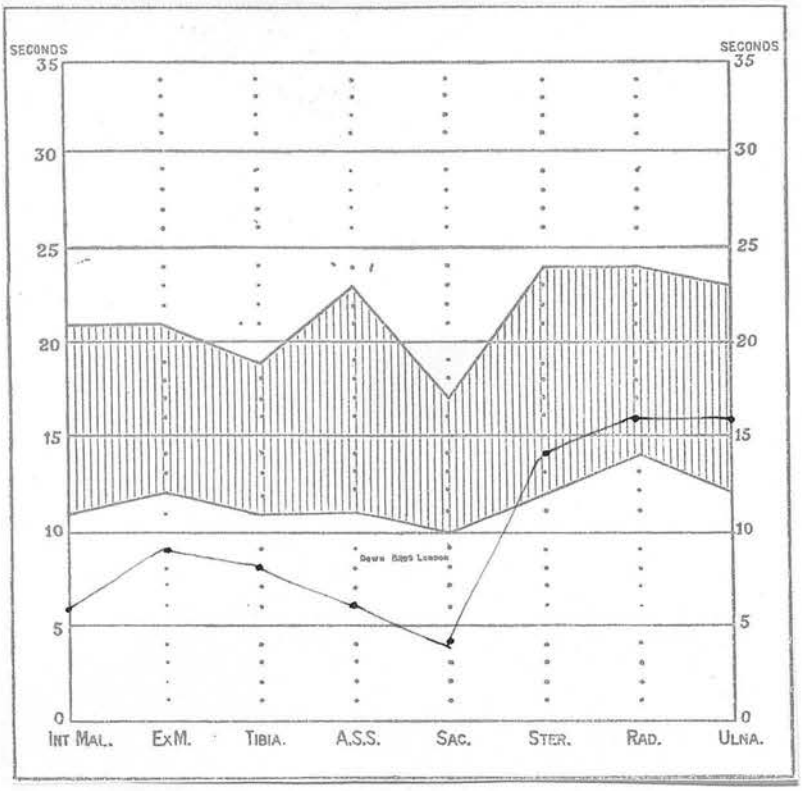
Weakness of flexor left wrist.

? Extensor response right side (Gordons and Oppenheimers signs)

Inability to hold deviation of eyes.

Four children, all well.

DIABETES MELLITUS, TWENTYFIVE CASES.



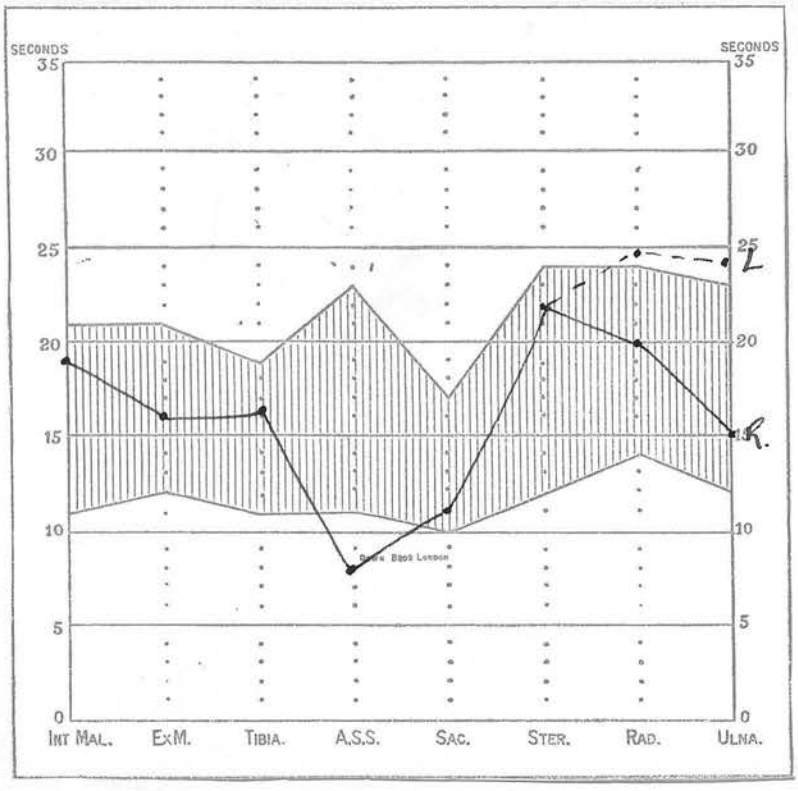
DIABETES

Clarence ADDY (42)
Upper Ozzings,
Shelley.

Thirst and polynria.

Glycosuria, no acetone bodies.

Has had sciatica.



DIABETES

Evelyn AMBLER (38)
2, Calder Street,
West Vale.

Has had diabetes for 13 years.

Sleepiness, especially in evenings, for 13 years. Thin eyebrows, harsh dry skin, occasionally pain in ankles.

Lungs Poor air entry.

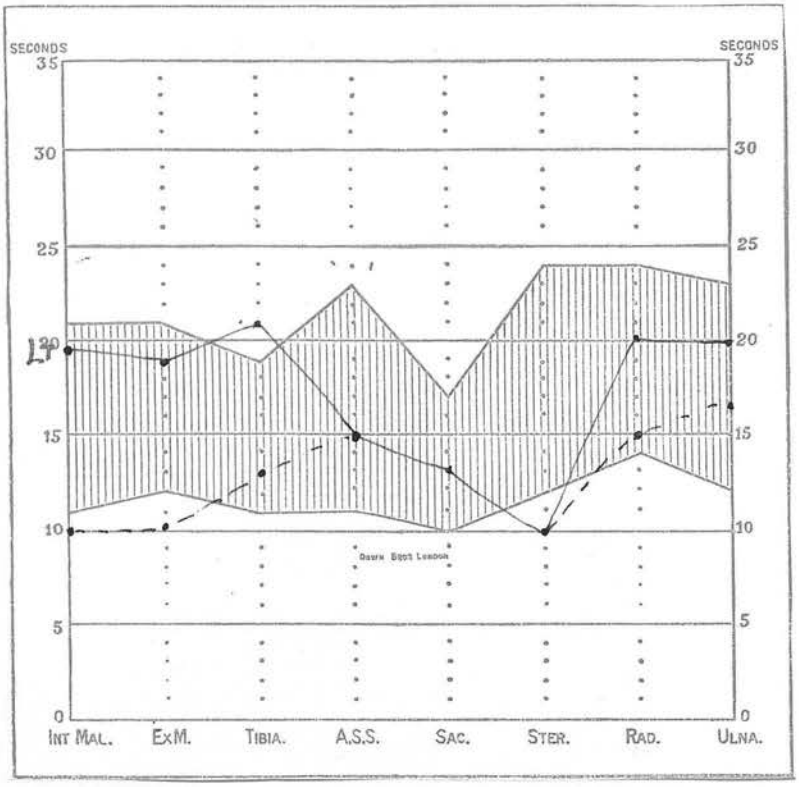
Heart More breathless than usual in last 12 months.

B.P. $\frac{140}{92}$

Slow speech, mental dullness.

Glucose Tolerance Test

Fasting Blood Sugar	200 mgs%
½ Hr after Glucose	250 mgs%
1 " " "	300
1½ Hrs " "	-
2 " " "	340



DIABETES

Sarah ATKINSON (59)
113, North Gate,
Huddersfield.

Diabetes for 5 years.

N.P.N. 37 mgms %

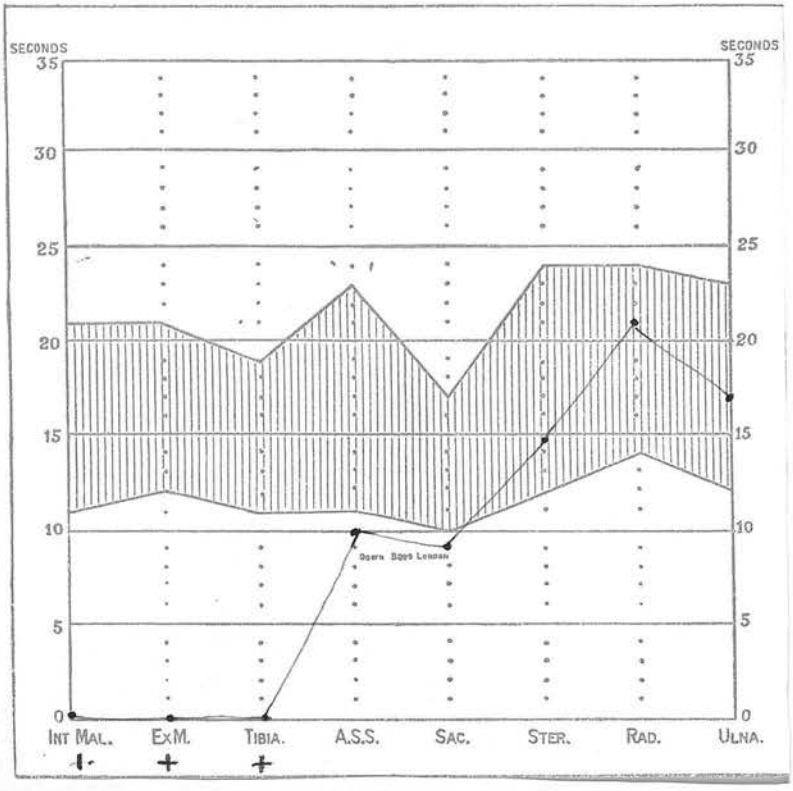
Blood Sugar 200 mgs %

Urine Pus and bacteria, granular casts and epithelial cells.

Albumen - present. S.G. 7020.

Sugar present.

B.P. $\frac{210}{100}$ Haemorrhagic retinitis.



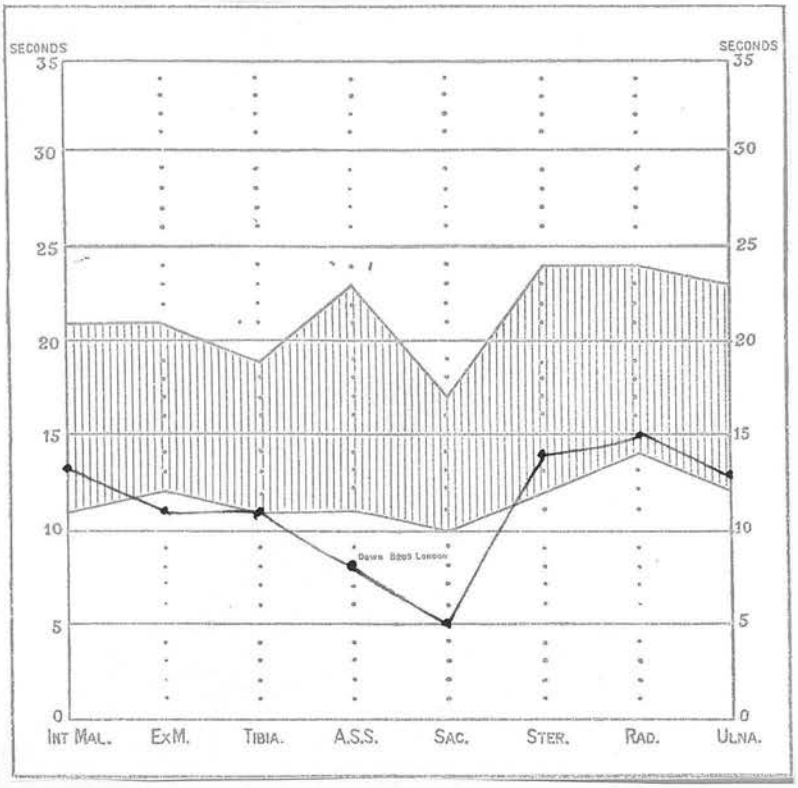
DIABETES

John AUCKLAND (59)
Oakleigh,
Lower Cumberworth.

Thirst, polyuria, lassitude for 3 - 4 months

Glycosuria.

Bronchitis.



DIABETES

Elsie BOOTH (44)
11, Armitage Road,
Milnsbridge.

Mother had diabetes.

Has been under treatment for diabetes for one year.

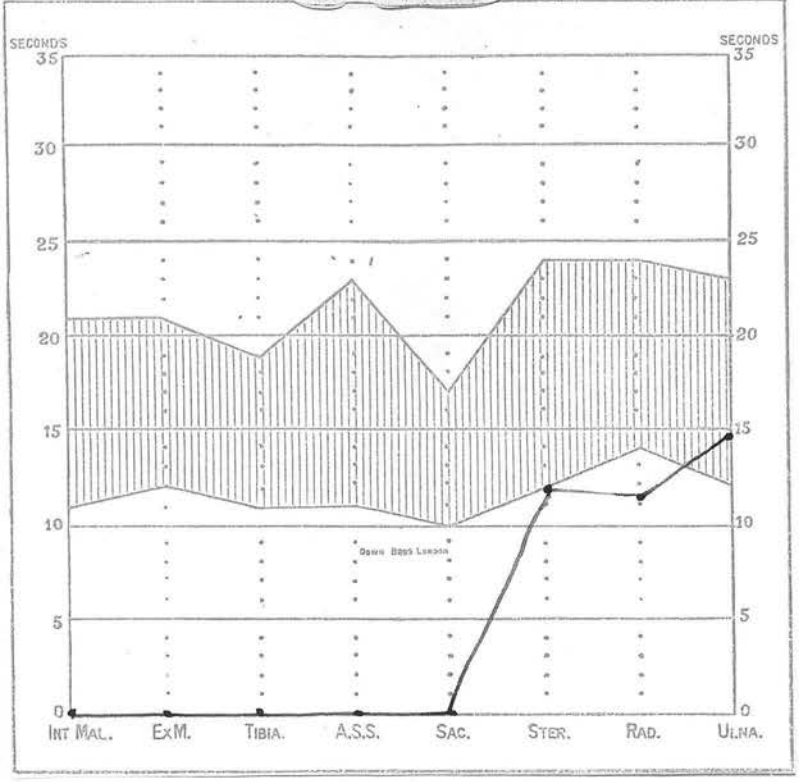
Pruritus and perineal boils.

B.P. $\frac{196}{116}$

Heart dullness increased to right. Accentuated aortic second sound. Faint aortic systolic murmur.

Blood Sugar 153 mgms %

W.R. negative.



DIABETES

Annie BOOTHROYD (64)
Westgate,
Almondbury.

Diabetes for 8 years. Felt out of sorts with cough for last 5 months, and has been confined to bed with difficulty in walking.

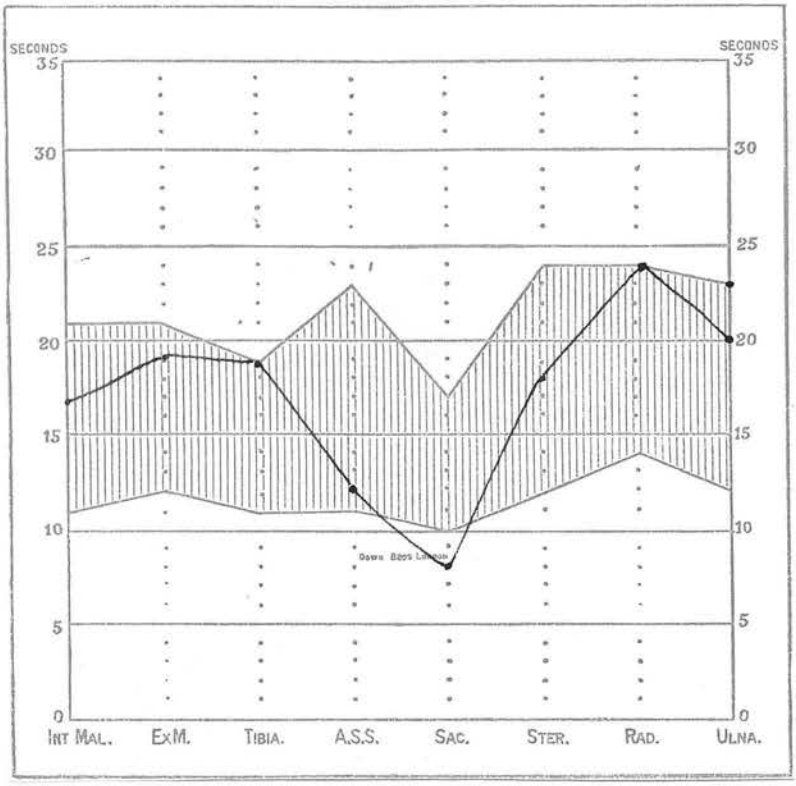
B.P. $\frac{148}{94}$

Knee and ankle jerks absent.

Blood Sugar 200 mgs %

W.R. negative.

Urine Catheter specimen, shows few pus cells and B. Coli and diphtheroid bacilli on films and culture.



DIABETES

Mary BRAMALD (33)
14, Lidget Street,
Lindley.

Father and brother died of diabetes.

History of recovery from Asthma.

Thirst for last 5 weeks.

Thin.

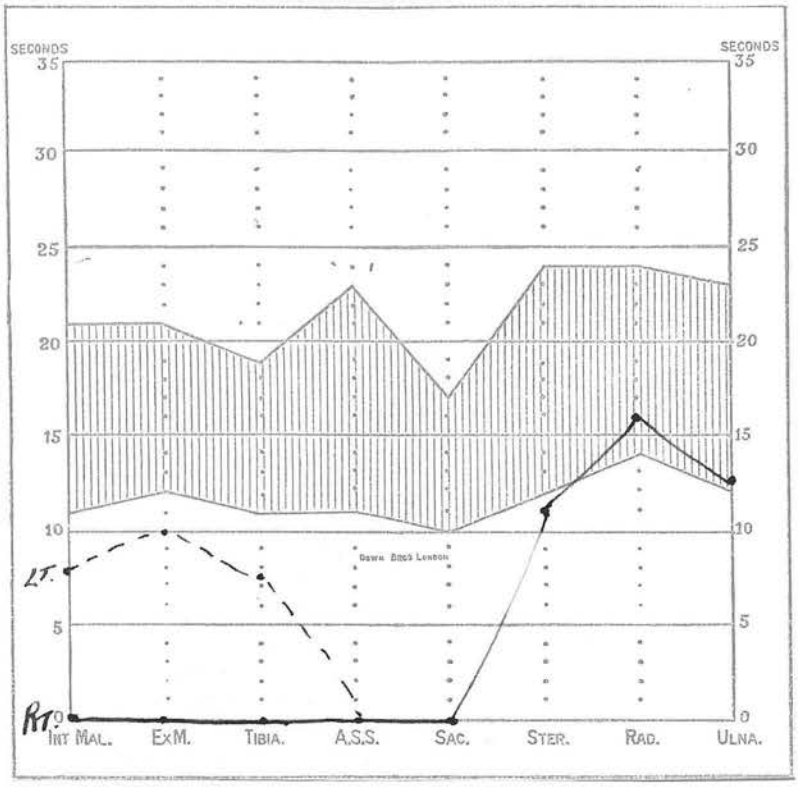
Lungs and Heart N.A.D.

Blood sugar 74 mgms %.

Sugar tolerance curve

Fasting blood sugar		95	mgms %
No	1.	149	"
	2	-	
	3	250	"
	4	240	

Urine 1st specimen reduced
2nd " ++ sugar



DIABETES

Priscilla BRAMMAR (58)
185 Church Street,
Paddock.

Known to have had diabetes for 10 years.

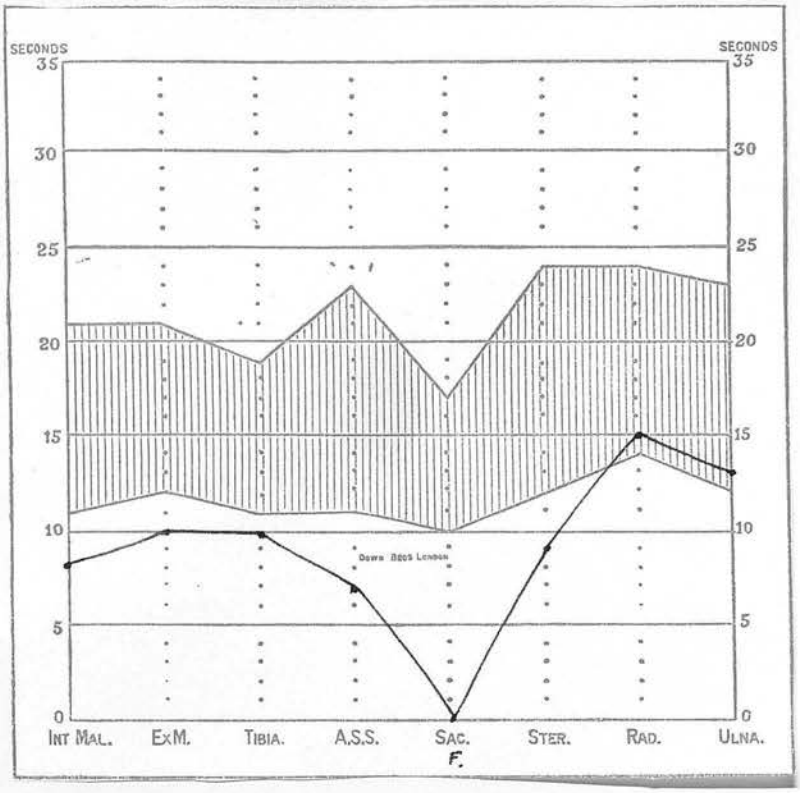
Lungs Patches of medium pitched bronchial breathing on both sides.

B.P. $\frac{200}{120}$

Accentuated aortic second sound.

Eyesight misty since March

Blood Sugar 285 mgms %.



DIABETES

Robina BRAY (54)
13, Head Wall Green,
Golcar.

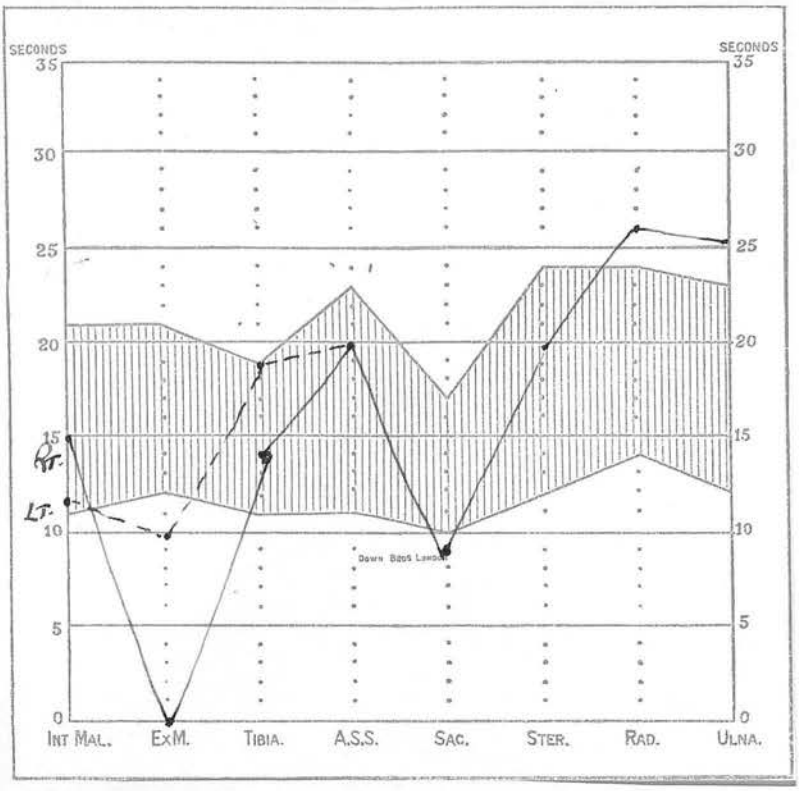
Fourteen days history of thirst and polyuria.

Obese, but losing weight.

Lungs N.A.D.

Blood sugars, 347 mgms %

Retinal Haemorrhagic retinitis with commencing cataracts.



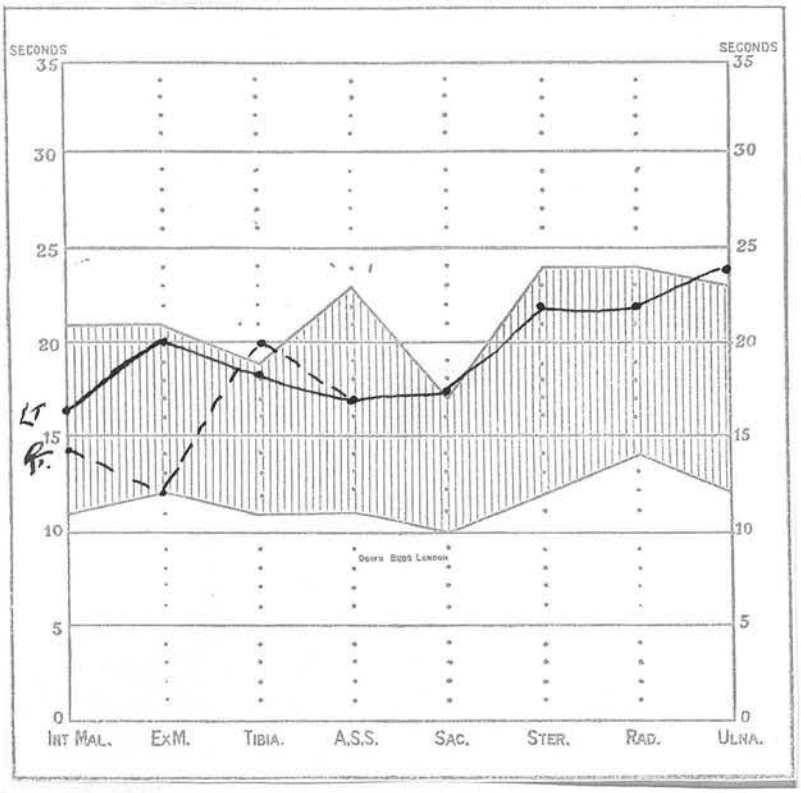
DIABETES

Harry CLEGG (52)
8, Friendship Terrace,
Meltham.

Lassitude for 12 months.

Known to have had diabetes for 3 weeks.

Lung and heart N.A.D.



DIABETES

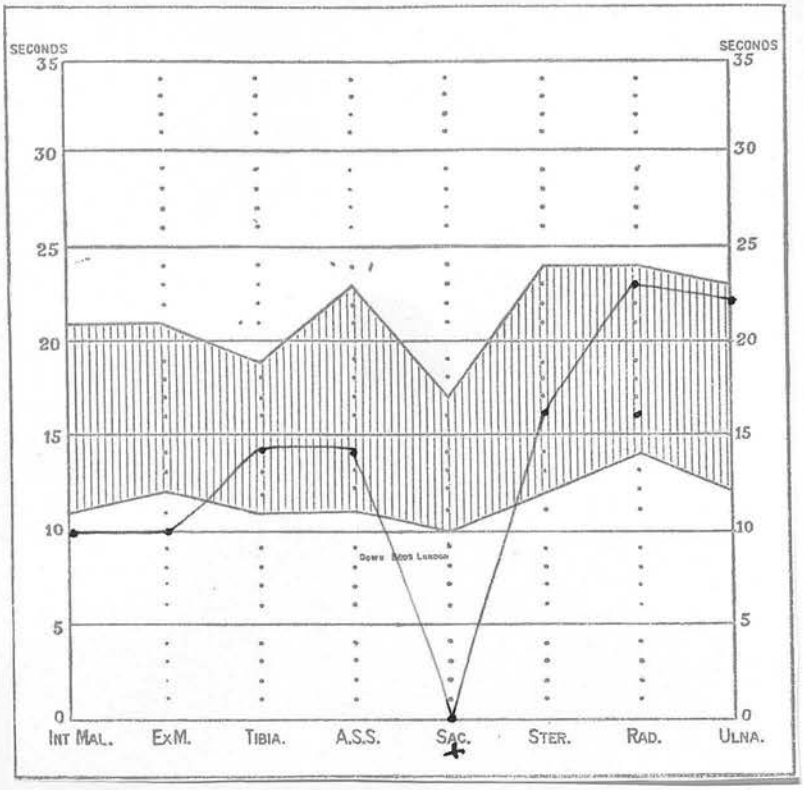
Frank HEY,
9, Heathdale Avenue,
Birkby.

Admitted with broncho-pneumonia.

Had thirst and polyuria for 5 months, and lost 3 stones in weight.

Blood Sugar 333 mgms %.

Much improved on discharge.



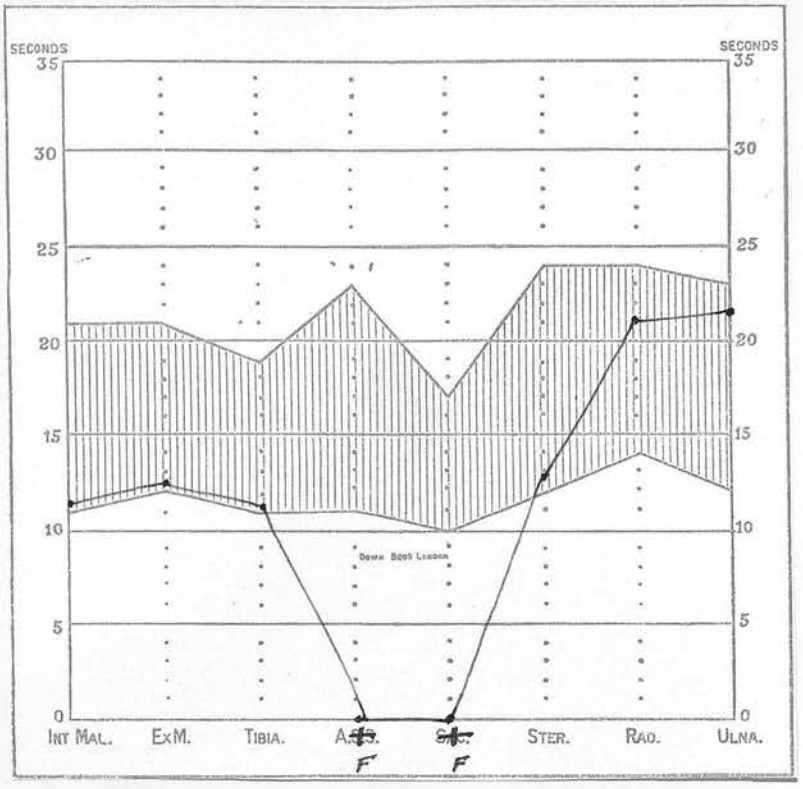
DIABETES

Ernest HOLDSWORTH (53)
38, Firth Street,
Rastrick.

Diabetes. Glycosuria for past 6 months.

Loss of weight and increasing thirst.

Blood Sugar 166 mgms %.

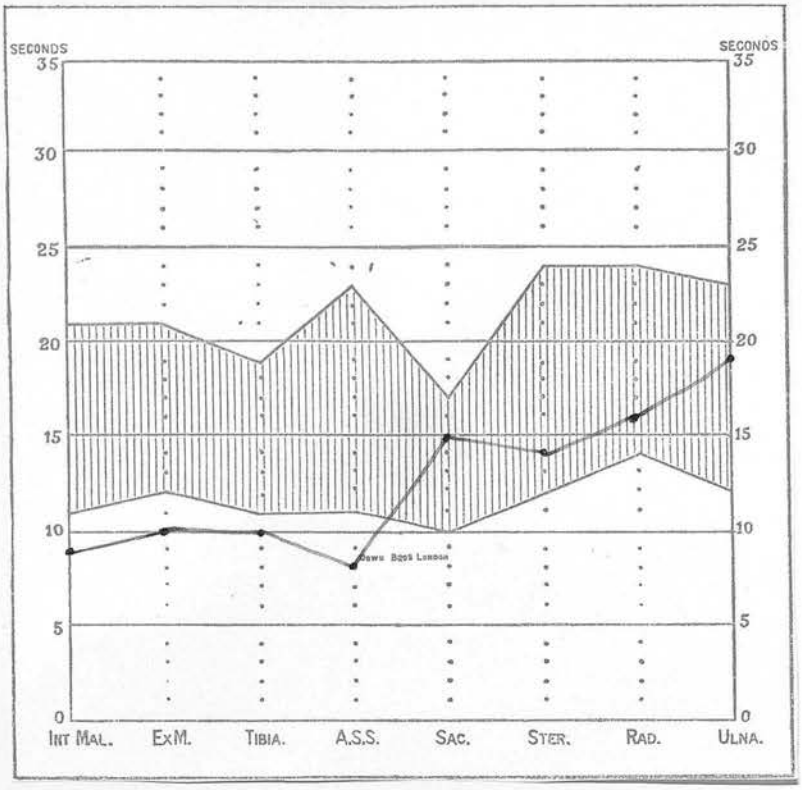


DIABETES

Annie JOHNSON (51)
141, Northgate,
Almondbury.

Diabetes for 6 years.

Fasting blood sugar 160 mgms %.



DIABETES

Sarah Jane LAYCOCK (70)
317, Blackmoorfoot Road,
Crosland Moor.

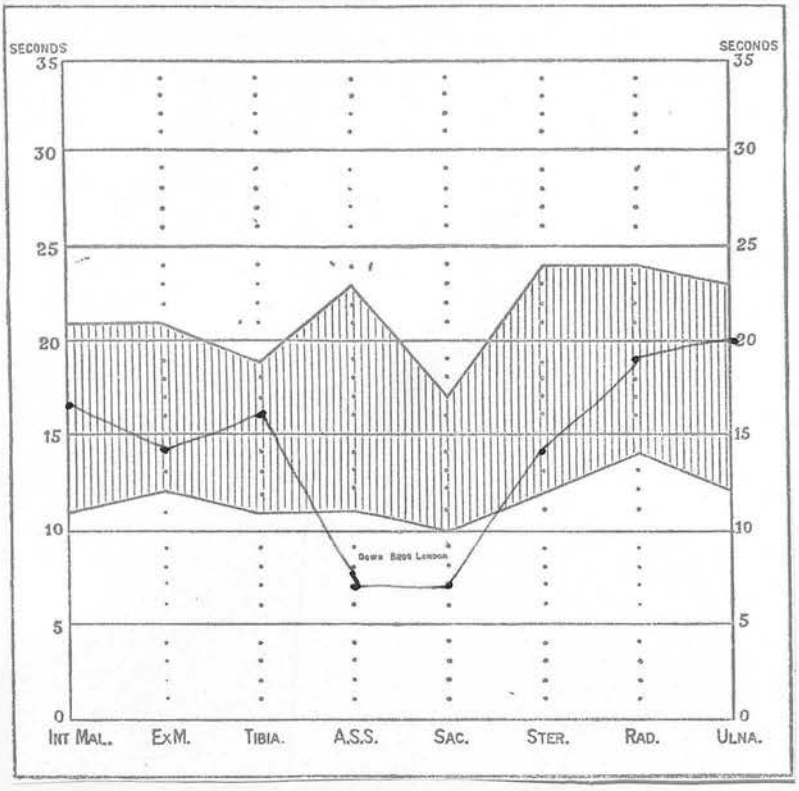
12 weeks before first admission was discovered to have glycosuria.

Had had "cerebral thrombosis" 2 years ago, no limb palsies.

Very poor memory.

Blood sugar 290 mgms %.

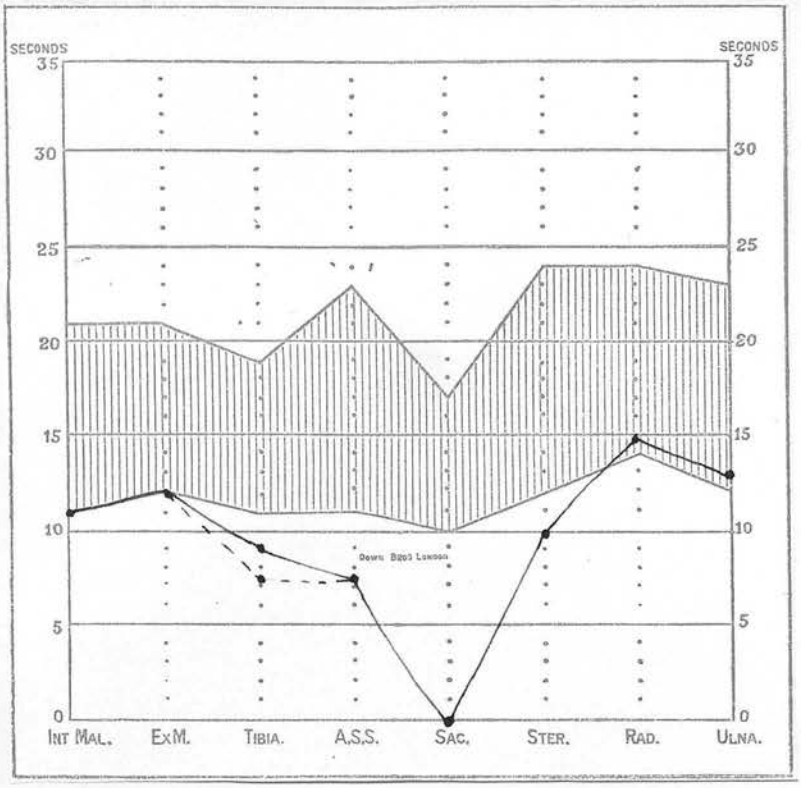
Readmitted two months later in coma. Recovered.



DIABETES

Harriet LEE (52) (under surgeons)
7, Chapel Lane, Milnsbridge.
Diabetes. Carbuncle of back.

Blood Sugar 133 mgms %.
190 mgms %.



DIABETES

Laura MARSDEN (54)
20, Clifton Common,
Brighouse.

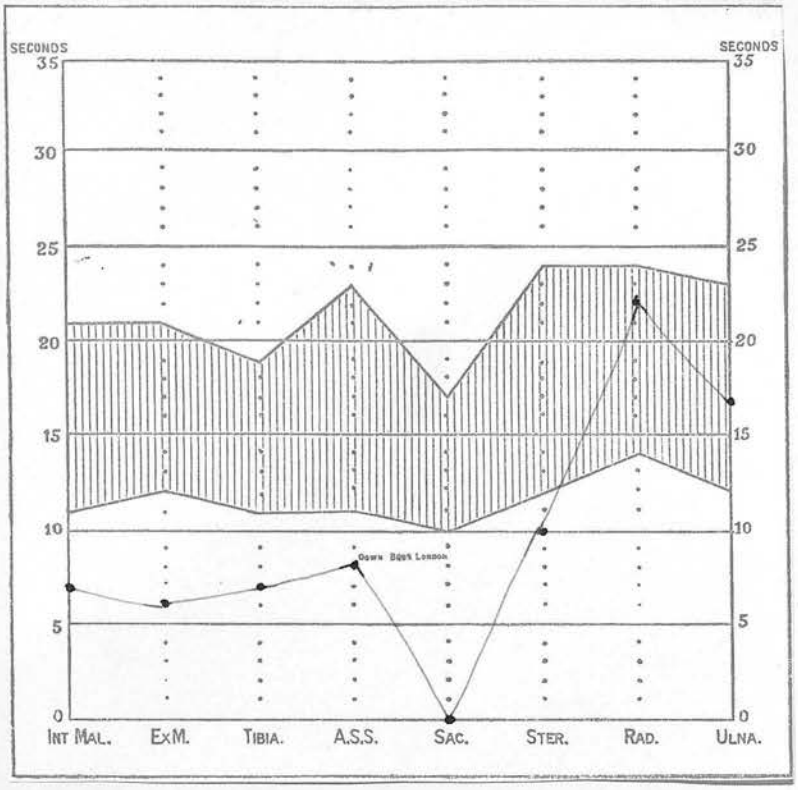
Mother died of Diabetes.

Lassitude for 6 months.

Polydipsia. Known to have had glycosuria for 3 weeks.

Abscess on sole of foot.

B.P. $\frac{160}{90}$



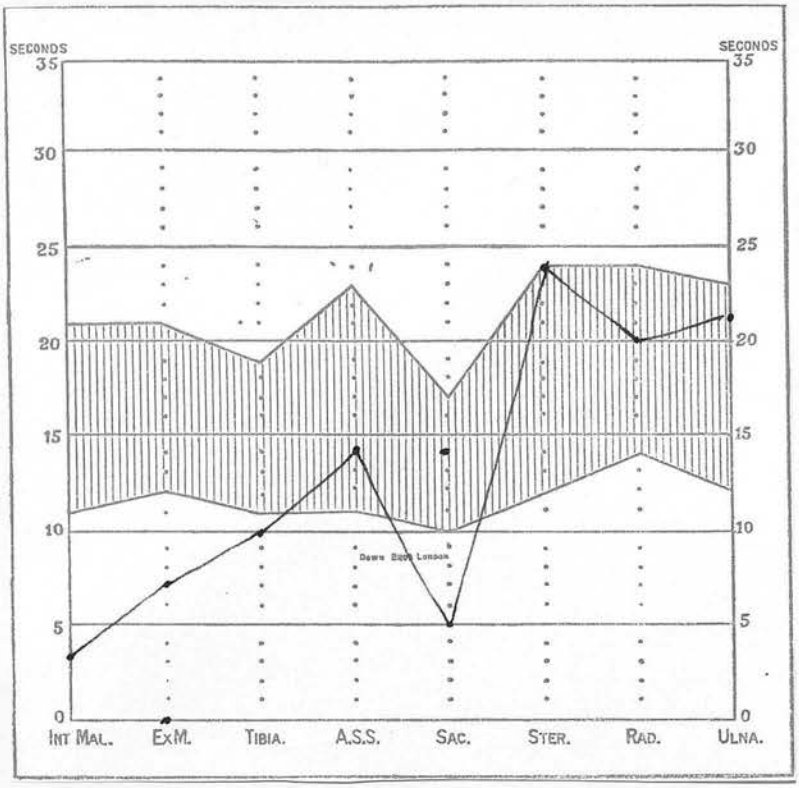
DIABETES

James MARSHALL (58) (under Surgeons)
180, Almondbury Bank,
Huddersfield.

Diabetic, with glycosuria.

Blood Sugar (Fasting) 200 mgms %.

Carbuncle of Chest wall and phimosis.



DIABETES

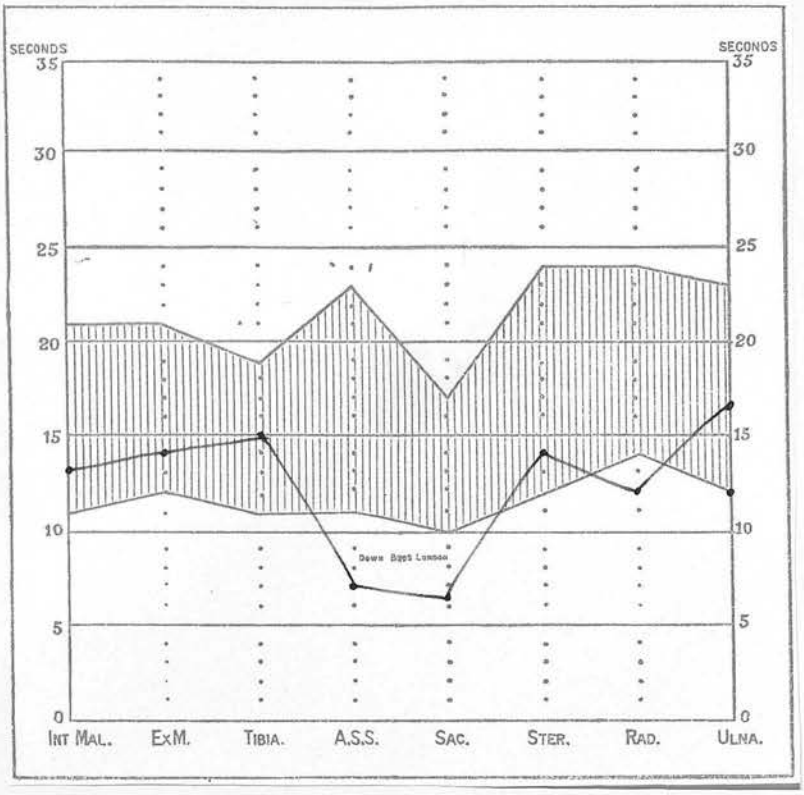
Frank MORRIS (54)
75, Barcroft Road,
Newsome.

Gangrene of second toe of right foot.
Duration 2 weeks.

No symptoms of diabetes.

Constant glycosuria.

Blood sugars 154 mgms %
130 mgms %



DIABETES

Harold PATERSON (33)
Workhouse Lane,
Kirkheaton.

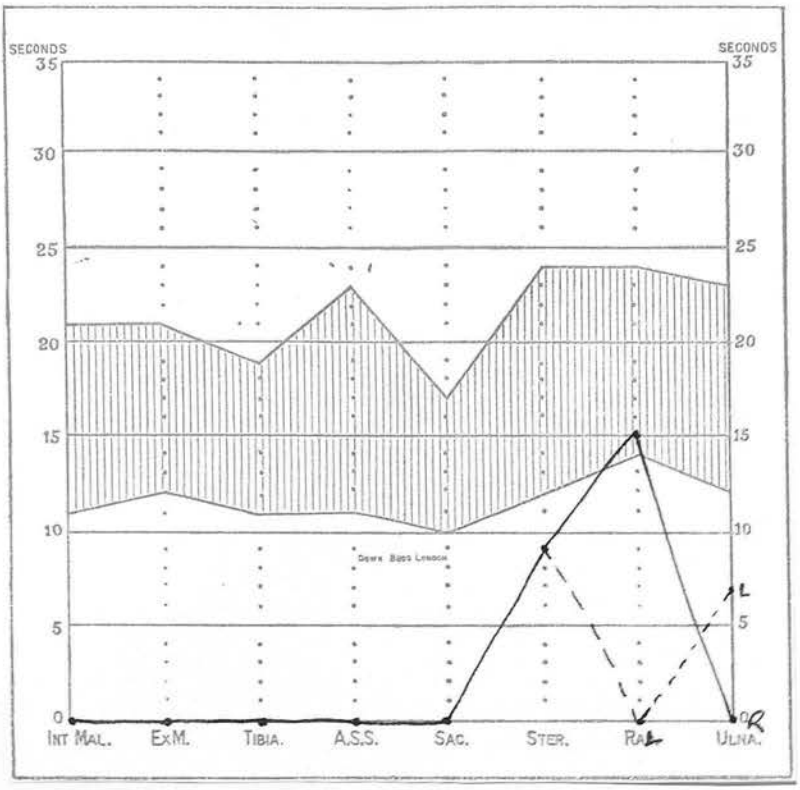
Glucose Tolerance test.

Fasting Blood Sugar	=	240 mgms %	
½ hr	=	306	"
1 hr	=	362	"
1½ hrs	=	306	"
2 hrs	=	-	"
2½ hrs	=	284	"

Insulin 40 + 30 + 35

Line Ration 16B + 8 R

Came in in coma.



DIABETES

Clara PEXTON (71)
11, Tandem
Wakefield Road,
Huddersfield.

Was attended by herbalist for 14 years, had Vulval irritation. Has known she has had diabetes for 3 years.

Complaint, Tiredness, and thirst,
Has had gangrene of toe of left foot.

Lungs N.A.D.

Heart Enlarged left ventricle, Second aortic sound accentuated.

Thickened vessels, B.P. $\frac{200}{90}$

Eyesight poor and deteriorating.

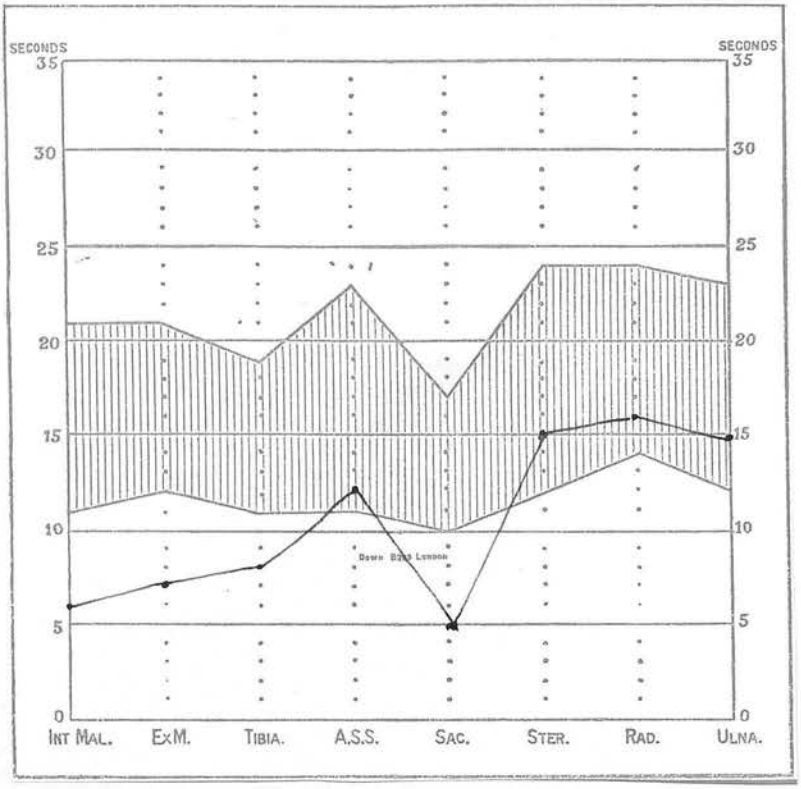
Frequency of micturition.

Urine. Pus cells and bacteria, R.B.Cs, yeasts, Hyaline and granular casts and epithelial cells. Albumen and sugar present, S.G. 1022, Reaction acid.

Blood sugar 200 mgms %.
N.P.N. 40 mgms %.

C.N.S. Normal.

Fundi Albuminuric retinitis.



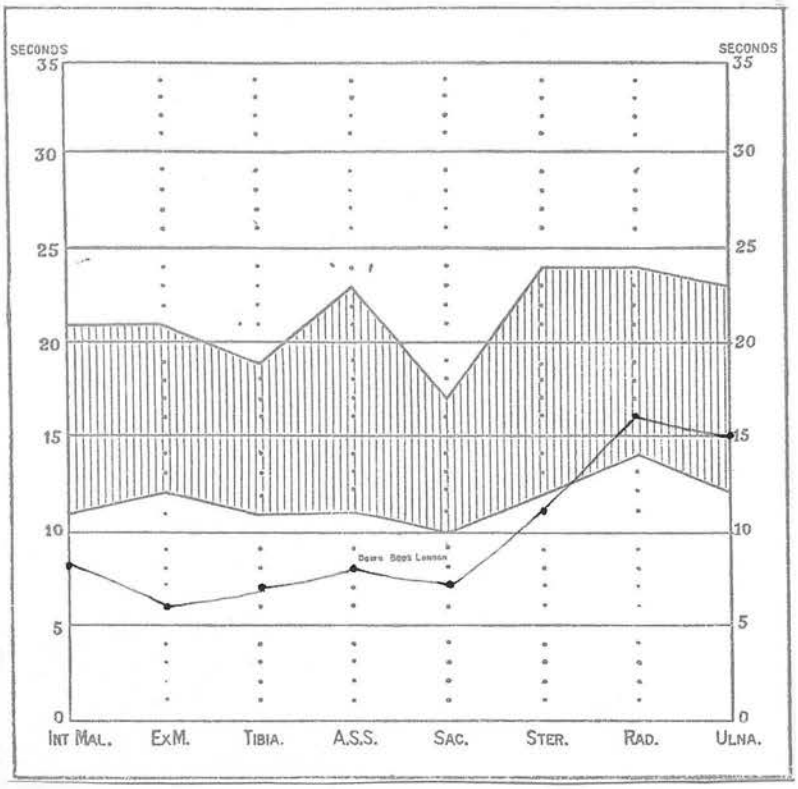
DIABETES

Joe PILLINS (51) (under surgeons)
777, Thornhill,
Outlane.

Diabetes. Gangrene of both legs.
Right removed below knee.

Fasting Blood Sugars

105	102
103	117
87	250
82	250
89	190
95	



DIABETES

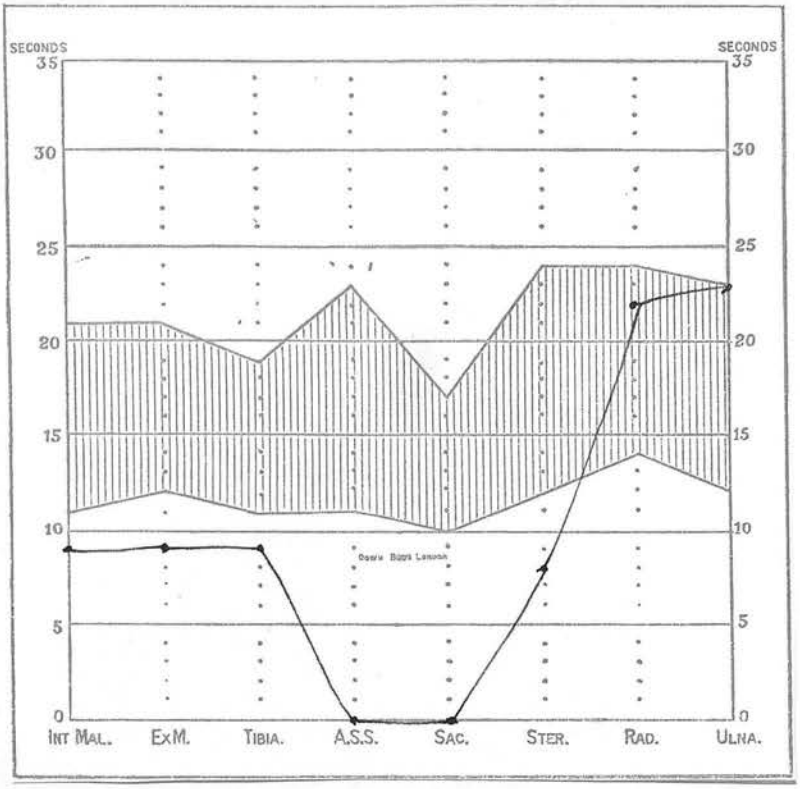
Sam ROWLEY (57)
69, Wood Lane,
Ashenhurst,
Newsome.

Hernia.

Then found to have diabetes.

Blood sugar 285 mgms %

B.P. $\frac{135}{50}$



DIABETES

Sam STANCLIFFE
6, Bradley Old Road,
Huddersfield.

Diabetes. No symptoms.

B.P. 178/100.

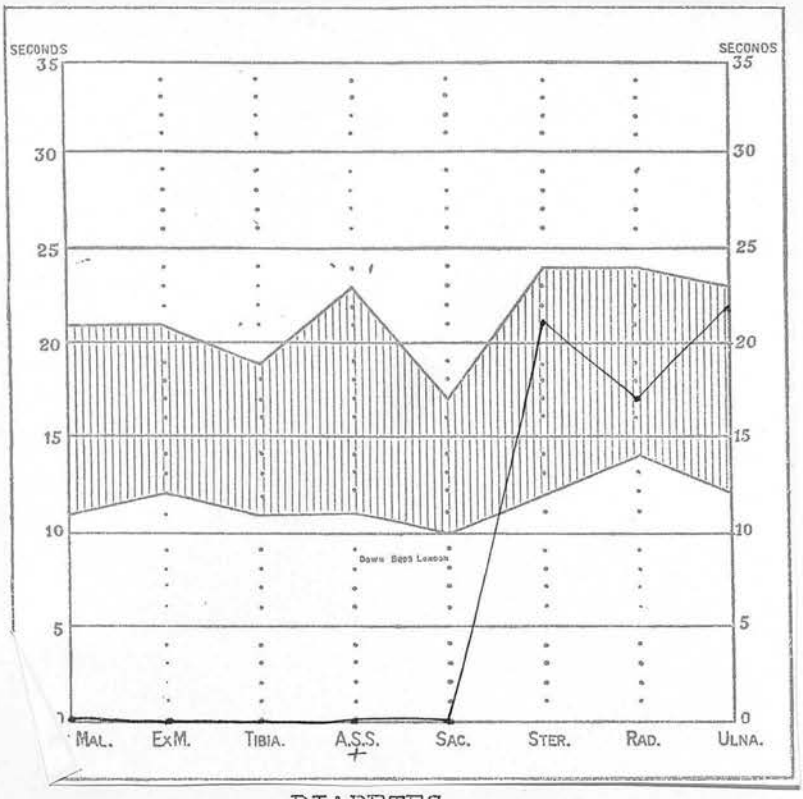
C.S.F. All tests normal.

W.R. Normal.

X-Ray Anterior and posterior tibial arteries calcified.

Gangrene of left foot, beginning in toes, now spreading to dorsum.

C.



DIABETES

Mrs Francis WATSON (63)
4, Wearley Terrace,
Meltham.

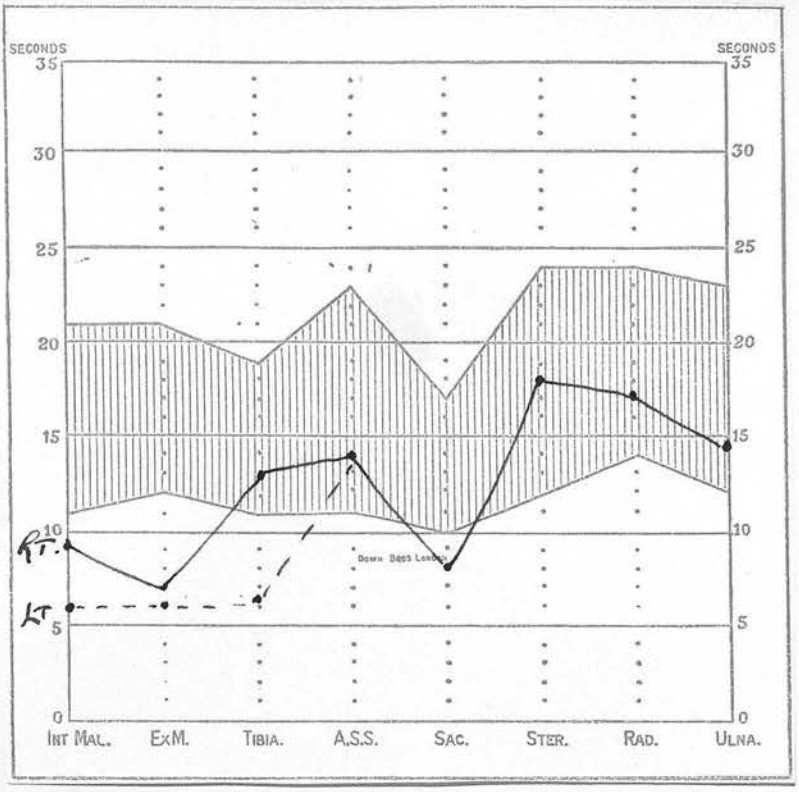
Diabetes for 8 years.

Simple goitre.

Gangrene of dorsum of right foot.

Right dorsalis pedis impalpable,
left palpable.

B.P. $\frac{170}{82}$



DIABETES

Tom WHITWAM
3, Small Lane,
Golcar.

Two brothers and two sisters with diabetes.

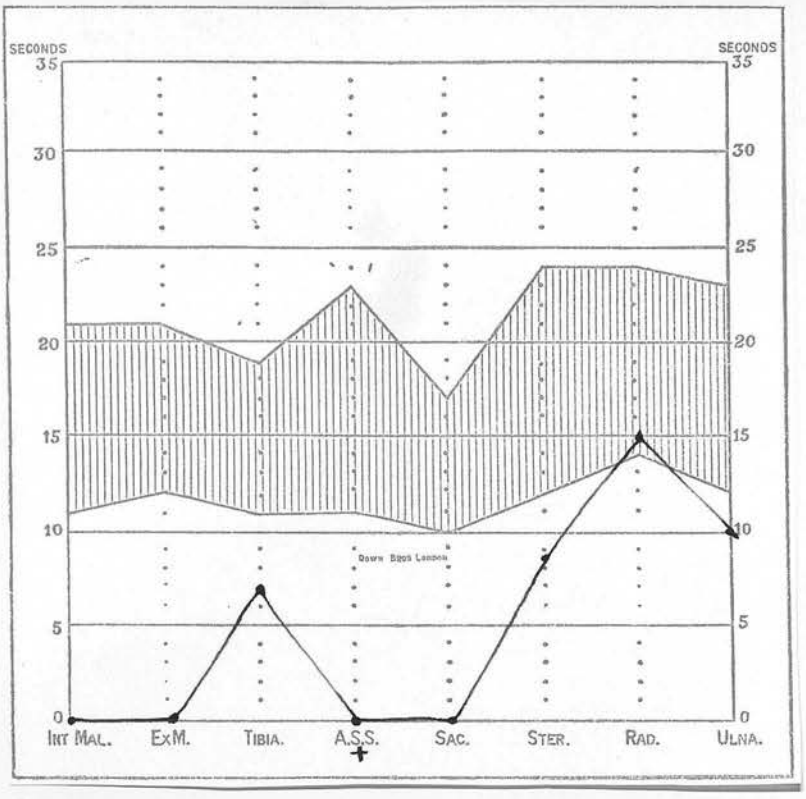
Known to have had diabetes for two weeks.

Lungs N.A.D.

Heart Diffuse pulsations in neck and epigastrium

B.P. 155/84

PERNICIOUS ANAEMIA, TWENTYFIVE CASES.



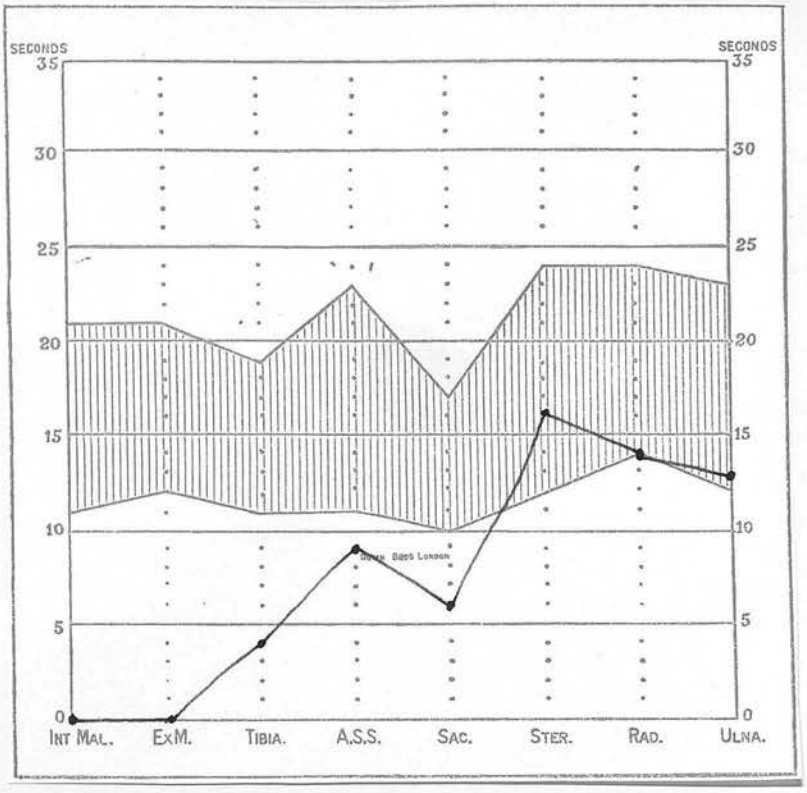
P.A.

Emma ARMITAGE (56)
Hallas,
Kirkburton.

Stomatitis, lassitude for three years.
Glossitis, anaemic.

Hb ... 70%
R.B.Cs ... 3,560,000.
C.l. ... 1.

Films typical of P.A.



P.A.

Herbert BERRY (54)
28, Waverley Street,
Slaithwaite.

Very severe P.A. eleven years ago, and
was treated by large doses of hydrochloric acid.

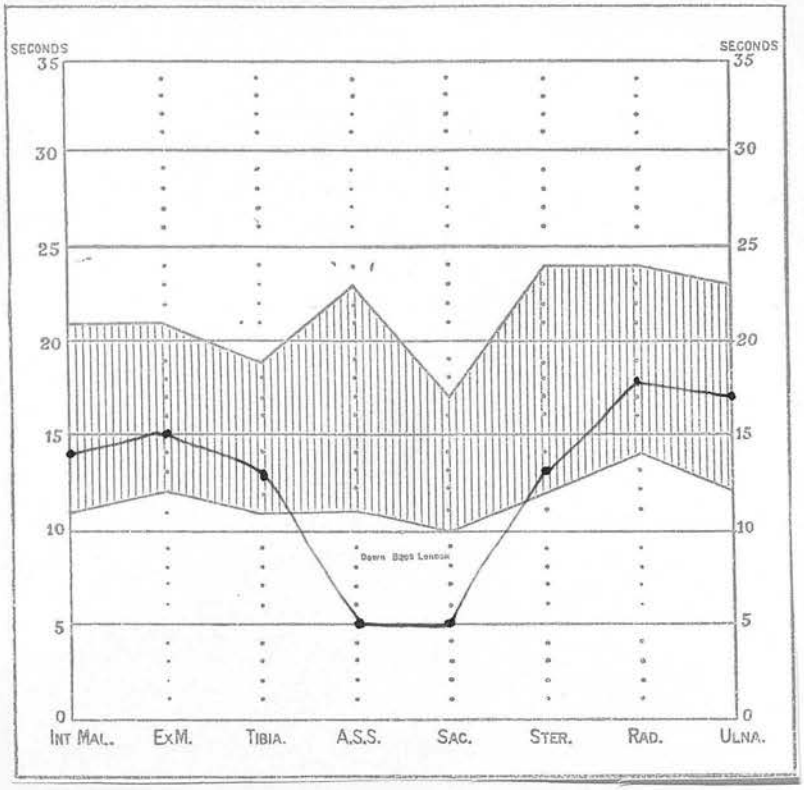
1930 Hb = 86%
R.B.Cs = 4,300,000
C.1 = 1

after being put on hepatex for a few months.

1933 Hb = 58%
R.B.Cs = 2,400,000
C.1 = 1·2

Films typical of P.A.

1935 Hb = 82%
R.B.Cs = 5,040,000
C.1 = ·8



P.A.

Mary BERRY (47)
11, Cowlersley Lane,
Milnsbridge.

1934 Tired, listless, dyspnoea, for 3 years.

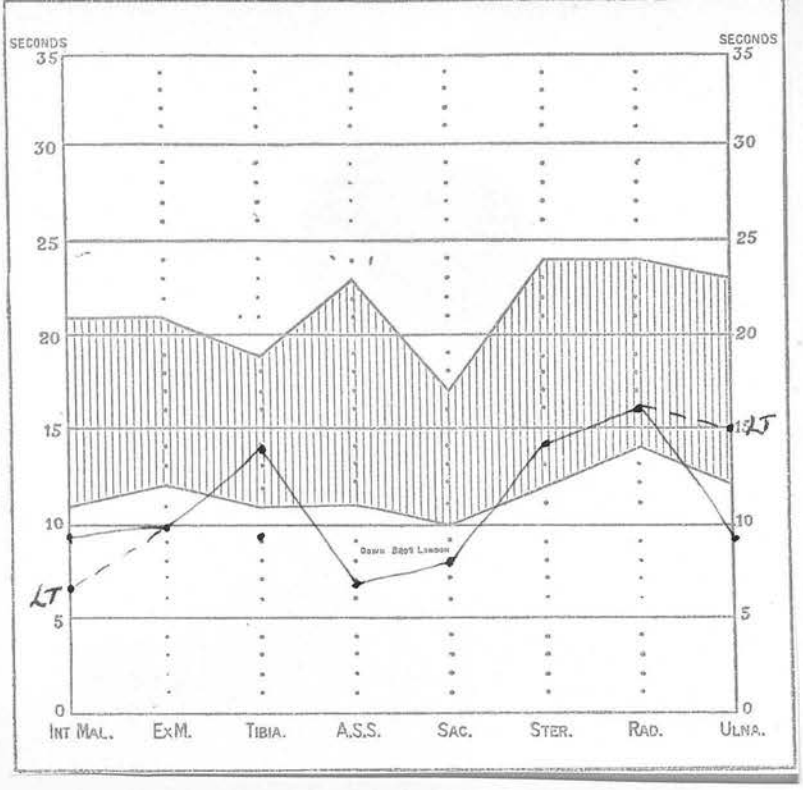
Mitral regurgitation (rheumatic fever, 1932)
Otherwise little of note, except pallor.

Hb = 60%
R.B.Cs = 2,320,000
C.I = 1·3

Film typical of P.A.

1935 R.B.Cs = 5000,000
Hb = 90%

CV.



P.A.

Clara BOOTH (41)
Revell Bottom,
Denby Dale.

Four years ago jaundiced.

Since then has been losing weight and complaining of palpitation.

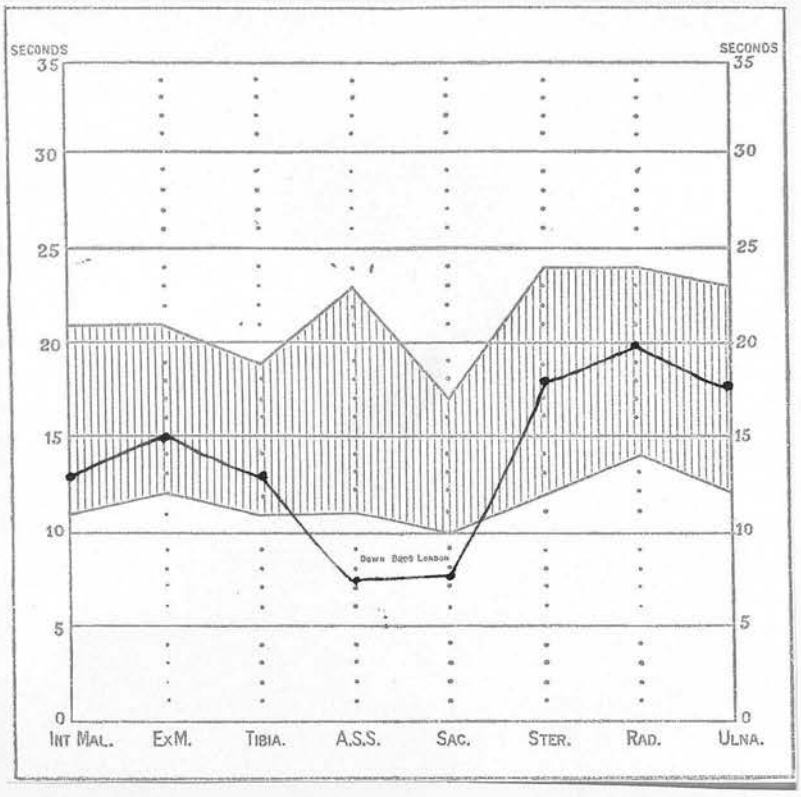
X-Ray stomach and gall bladder normal.

Test meal Complete achlorhydria.

Blood count.

R.B.Cs	2,200,000
W.B.Cs	3,600
Hb	46%
C.1	1

Anisocytosis, poikilocytosis, polychromasia and punctate basophilia.



P.A.

Marjorie CLARK (31)
24, Birkby Lodge Road,
Birkby.

Extreme pallor. Lemon tinge.

Oedema of feet and legs. No glands, neither liver nor spleen palpable.

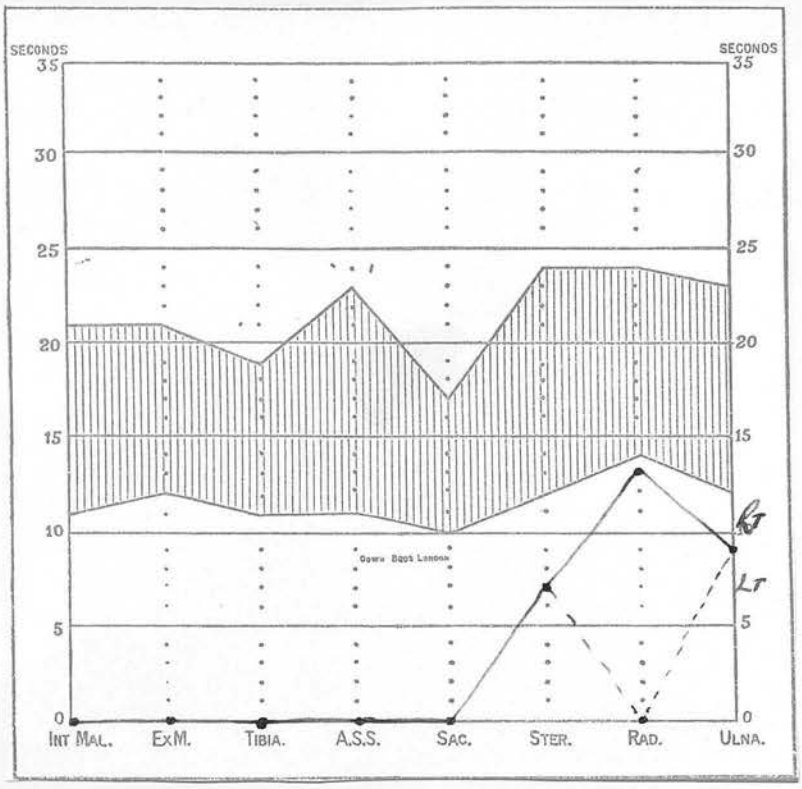
Tongue atrophied.

Haemic systolic bruits over precordia. Pulmonary second sound accentuated.

Amenorrhoea for 2 months.

Blood Count Hb = 22%
R.B.Cs = 980,000
W.B.Cs = 6,000
C.I = 1·1

Films show features of pernicious anaemia.



P.A.

Edith CREIGHTON (43)
Springfield Terrace,
Emley Moor.

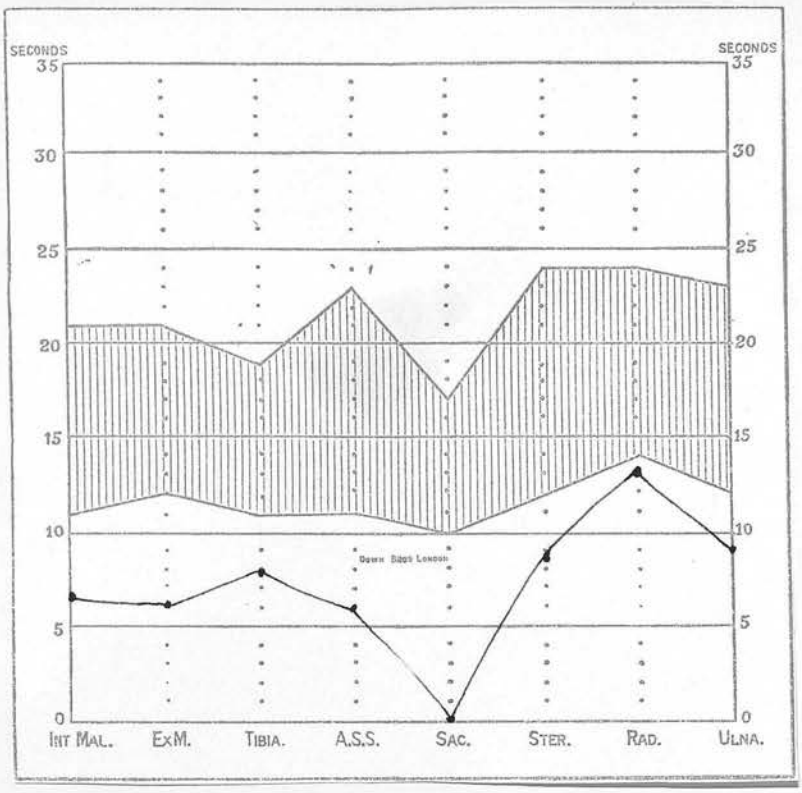
Patient has been ill for 5 months.
Commenced with left sided abdominal pain.

1933 Pallor, septic teeth.

Hb = 50%
R.B.Cs = 2,200,000
C.I = 1·1

Film typical of P.A.

1935 R.B.Cs = 5,480,000
Hb = 80%
C.I = ·8



P.A.

Kate DAWSON (70)
10, Bank Top,
Lowerhouses.

Rheumatic Fever aet. 15

Influenza last Christmas. Has been feeling poorly since then, lassitude and weakness.

Skin Lemon yellow.

Lungs Emphysema.

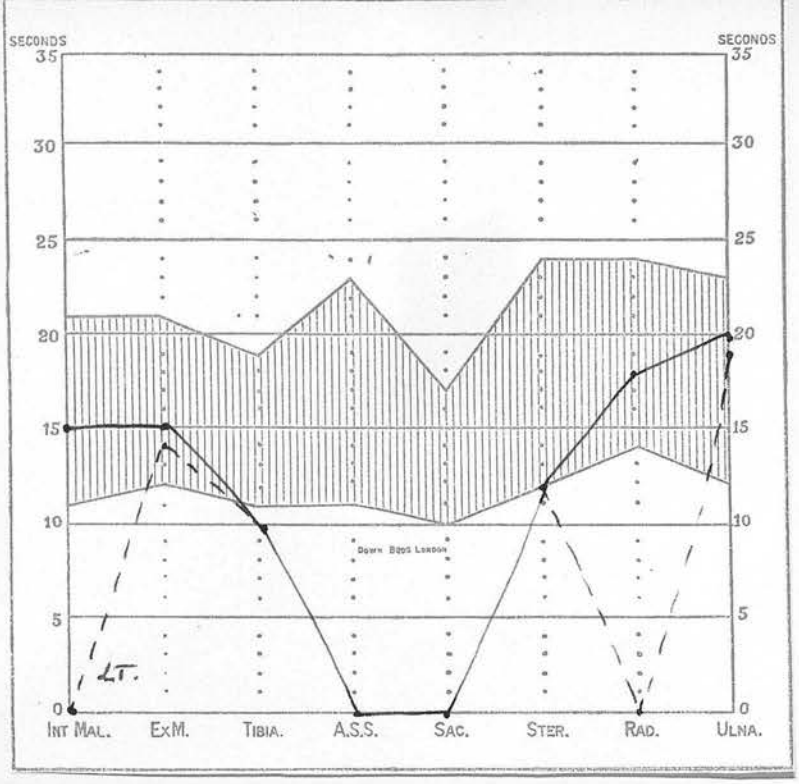
Heart Breathlessness on exertion. Double murmur at mitral area. Systolic at aortic, and accentuated aortic second sound.

Appetite Fair. Diarrhoea.

Tongue Atrophic.

Hb = 38%
R.B.Cs = 1,420,00
C.I = 1·3
W.B.Cs = 4,000

Typical picture of pernicious anaemia.



P.A.

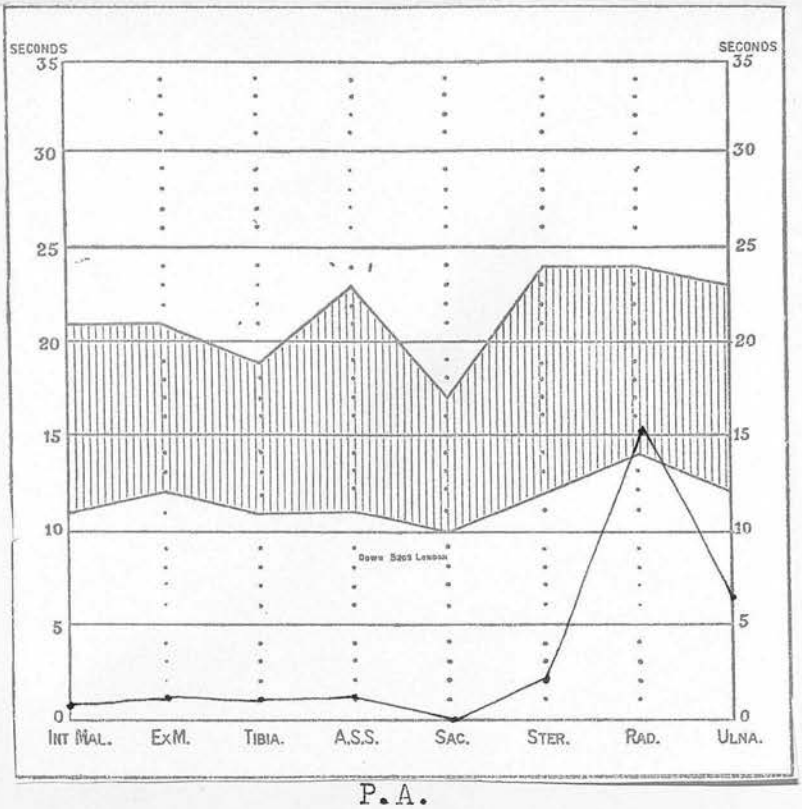
Mrs. Dallas (70)

Blood Counts

Hb	42%	17.6.35
R.B.Cs	1,600,000	
W.B.Cs	3,800	
C.1	1·3	

Macrocytes, nucleated reds, anisocytosis, reticulocytosis, punctate basophilia.

Hb	84%	
R.B.Cs	4,500,000	22.8.35
C.1	·93	



P.A.

Eliza DYSON (59)
10, Main Avenue,
Cowlersley,
Milnsbridge.

Loss of energy for 5 weeks. Legs gave way. Anorexia, vomiting. Haemorrhage from mouth day before admission.

Pigeon breasted.

Mitral systolic murmur.

Flaccid abdominal wall with divarication of recti. Spleen palpable.

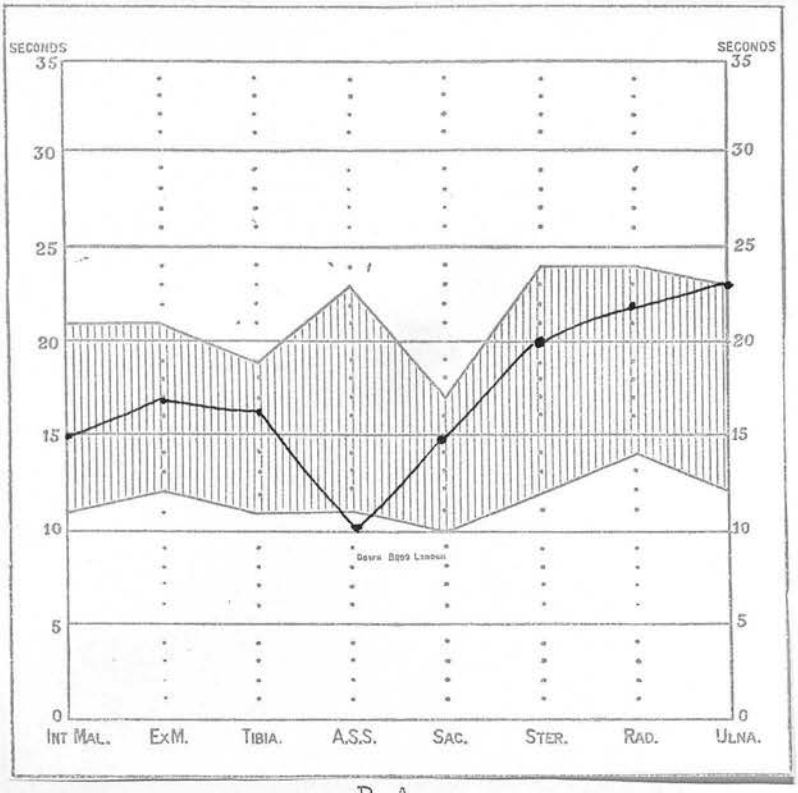
Appetite poor. Tongue atrophic. Complete achlorhydria.

Numbness and cramp in hands and feet.

Blood examination
R.B.Cs = 1,200,000
Hb = 28%
C.I = 1·1

Films confirm diagnosis.

Anaemic for 35 years.



P.A.

Ada ELLIS (44)
10, Ings Road,
Almondbury.

Mother died of Pernicious Anaemia.

Symptoms began 12 months ago with breathlessness and pains in shoulders.

Skin Lemon yellow colour.

Tongue Atrophied.

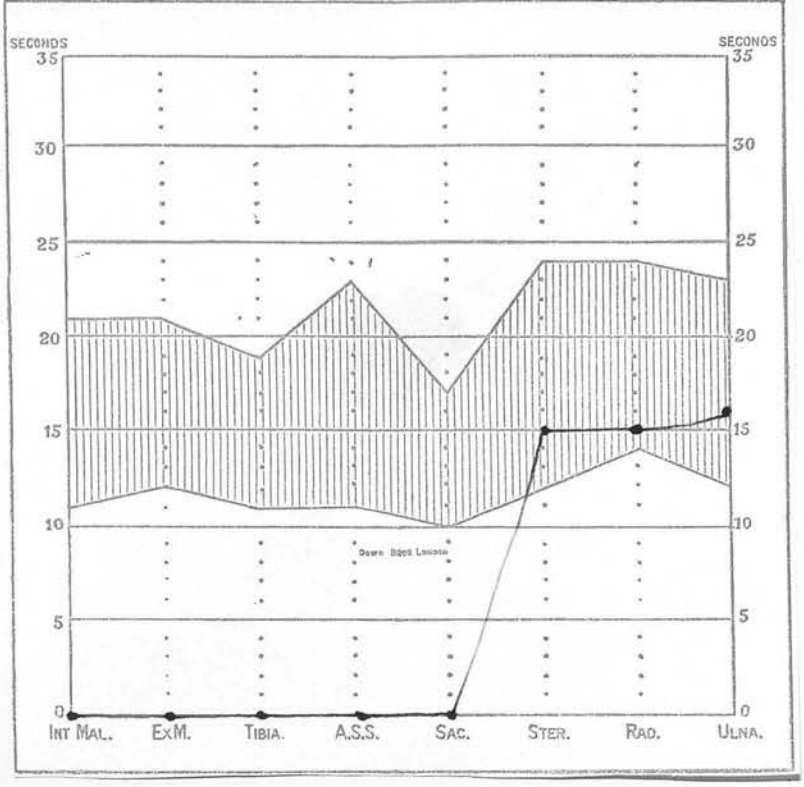
Spleen Palpable.

Heart Blowing systolic murmurs at all areas.

Blood count

Hb = 20%
R.B.Cs = 1,170,000
W.B.Cs = 5,000
C.I = about normal (1)

Films show a typical severe P.A.



P.A.

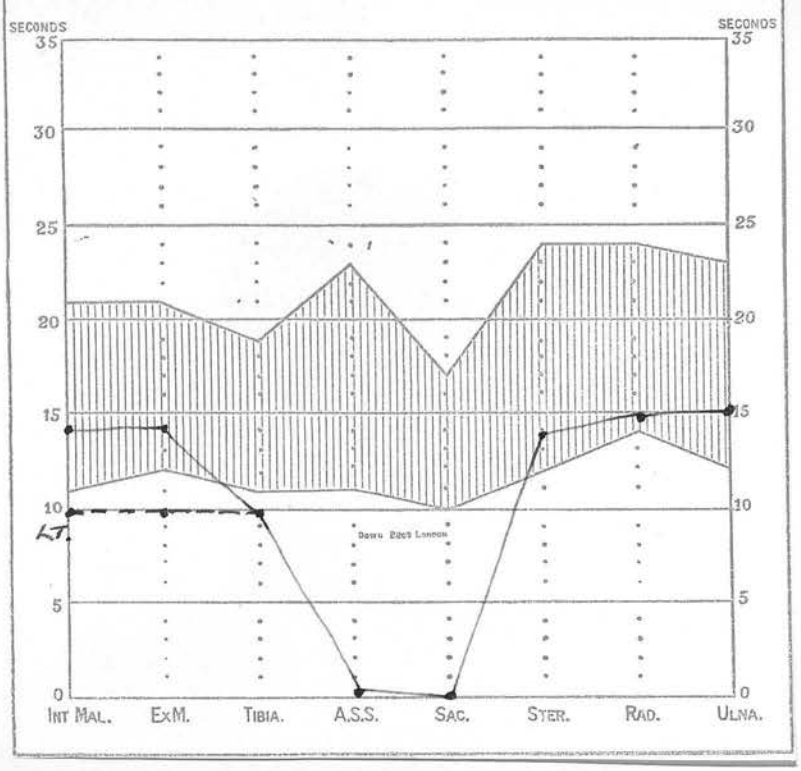
Lily FIELD (61)
1, Brick Bank,
Almondbury.

1932 Very marked anaemia, said to result from haemorrhoids. Prolapse of rectal mucosa.

Hb = 45%
R.B.Cs = 1,880,000
C.I = 1·2

Films typical of pernicious anaemia.

1935 Hb = 70%
R.B.Cs = 3,100,000
C.I = 1·2



P.A.

Florence GRAHAM (49)
Town End,
Emley.

Constipation, vomiting, dry mouth, Poor appetite.

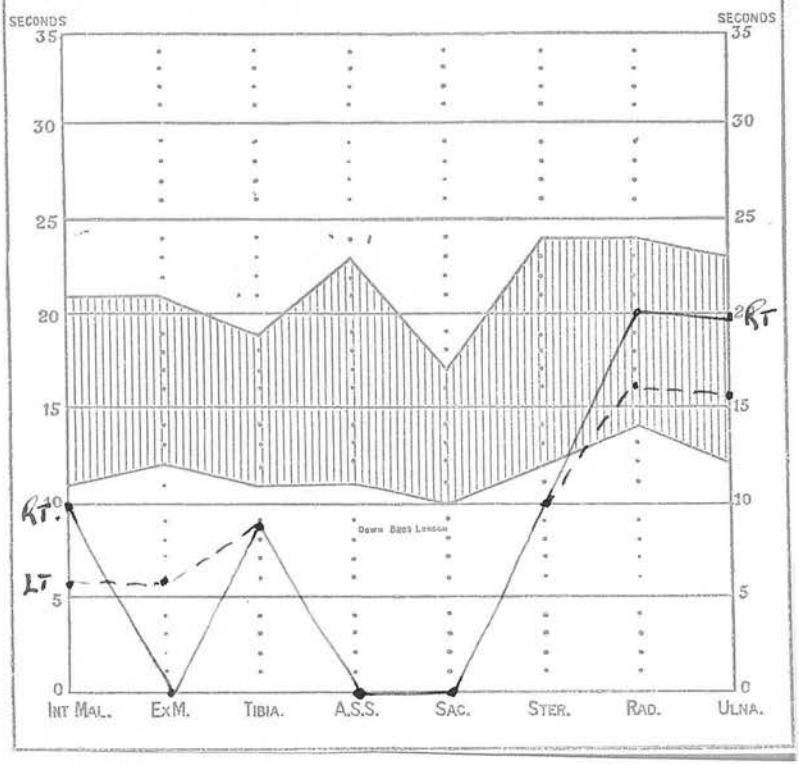
Atrophic tongue.

Complete achlorhydria.

Blood count

Hb	64%
R.B.Cs	3,120,000
W.B.Cs	5,000
C.1	1·03

Macrocytosis, poikilocytosis and nucleated reds.



P.A.

Sarah Jane HAIGH (71)
5, High Close,
Almondbury.

Recurring periods of ill health.

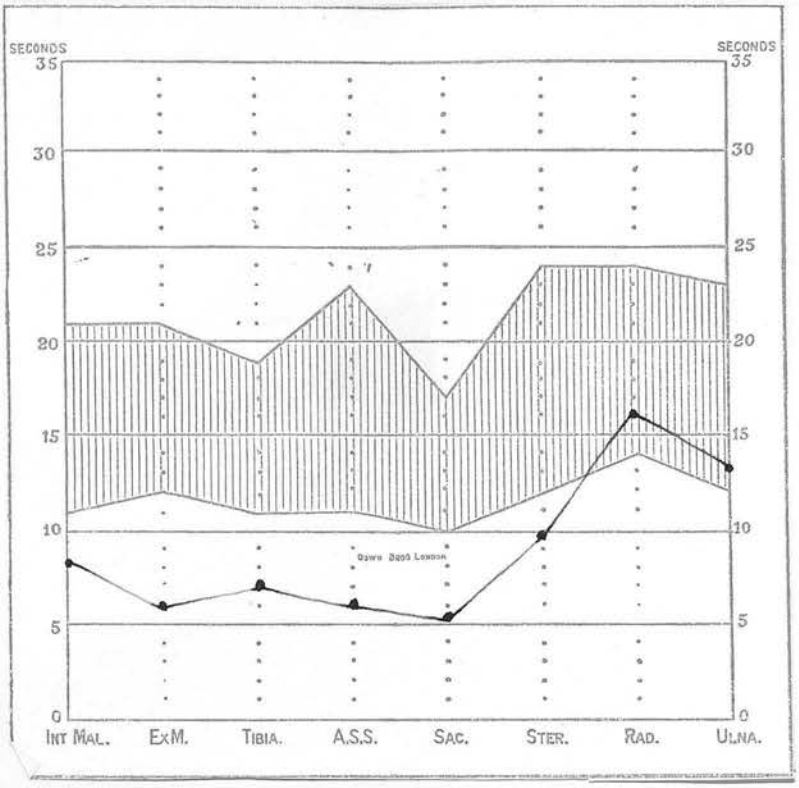
Anaemic and dyspeptic.

Diplopia, albuminaria.

Blood count

Hb	48
R.B.Cs	2,000,000
W.B.Cs	5,600
C.1	1·2

Marked macrocytosis and anisocytosis.



P.A.

Eva HIRST (44)
Flockton,
Nr. Wakefield.

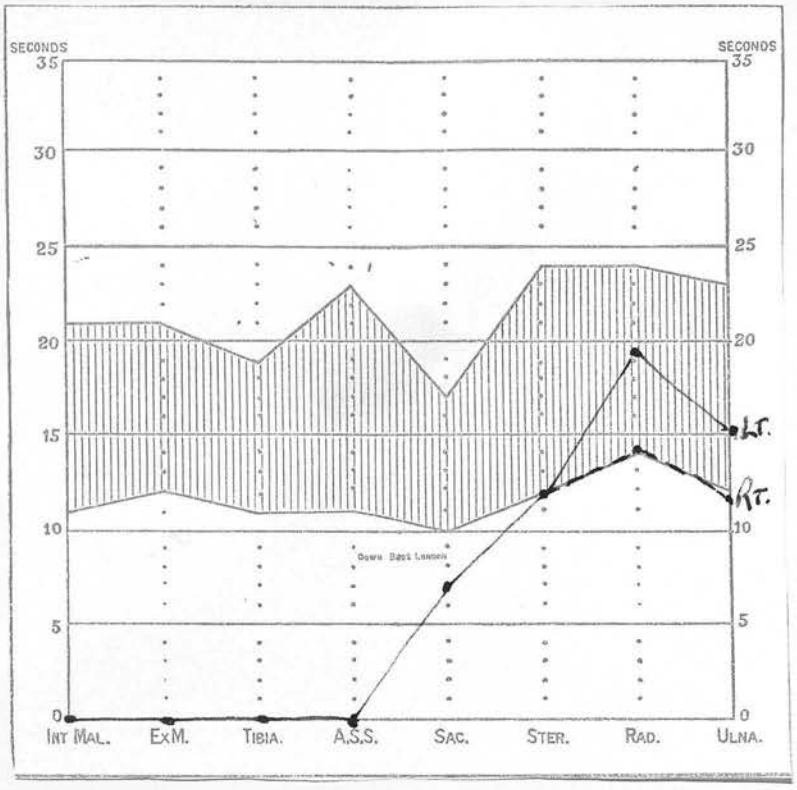
Weakness with syncope for several months. Typical lemon yellow colour, with blanching of mucous membranes.

Heart Weak sounds with haemic bruits.

Well nourished.

R.B.Cs = 1,240,000
Hb = 46%
C.I = 1·2

Films typical of P.A.



P.A.

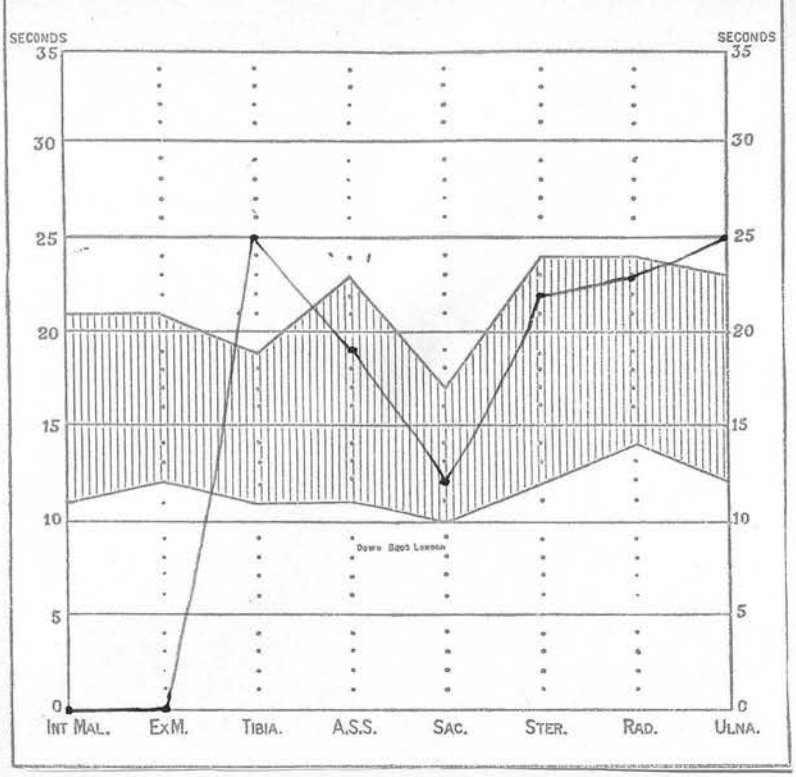
George JACKSON (44)
71, Horley Green Road,
Halifax.

1928 Subacute combined degeneration, main feature paraethesiae.

1929 R.B.Cs = 5,600,000
Hb = 90%
C.1. = 0·8

1934 R.B.Cs = 3,480,000
Hb = 85%
C.1 = 1·2

1935 R.B.Cs = 4,010,000
Hb = 80%
C.1 = 1·0



P.A.

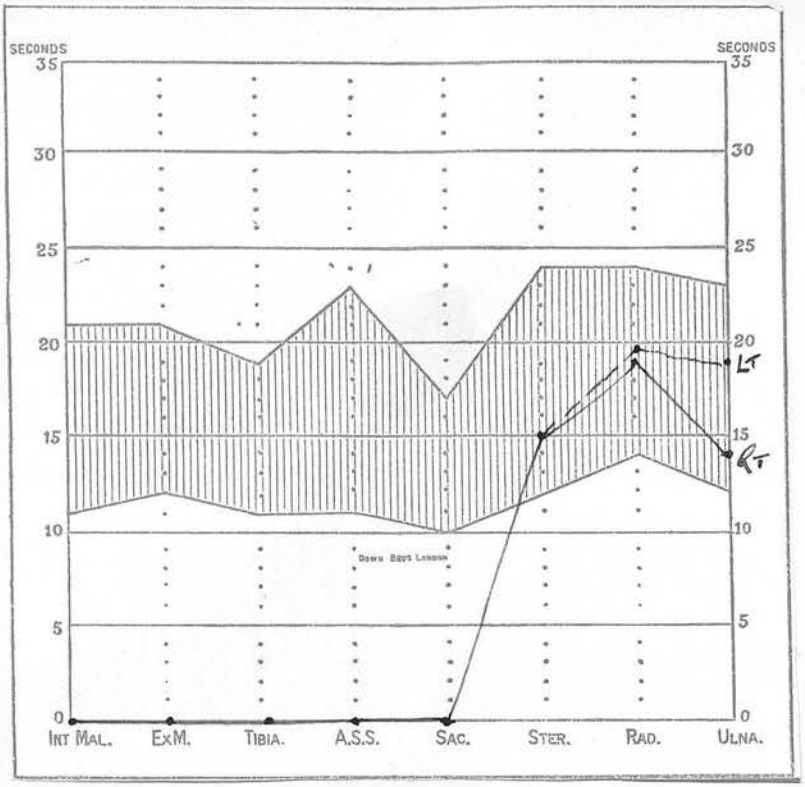
Isaac JONES (56)
18, Chapel Lane,
Milnsbridge.

Hb = 60%
R.B.Cs = 2,690,000
C.1 = 1·1

Film confirms P.A.

W.R. negative.

Numbness of legs and feet for 4 months.
Cold feet. Girdle pains in abdomen.
Difficulty in walking, 12 weeks.
Rhombergism.
Knee and ankle jerks increased.
Knee clonus.
Plantar reflex flexor.



P.A.

Edwin MOORHOUSE (72)
5, Dyson Hill,
Honley.

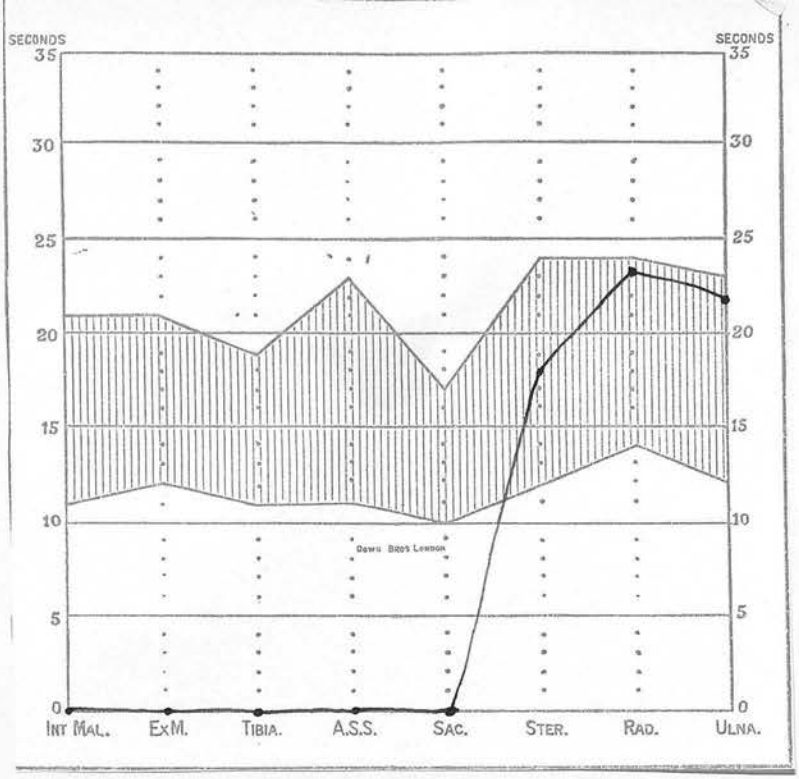
Admitted six months ago for an questionable partial intestinal obstruction. Found to be due to constipation.

X-Ray N.A.D.

C.N.S. Reflexes present, no Rhombergism. Vibration sense absent at malleoli.

F.T.M. Achlorhydria $\frac{-}{c}$ marked blood throughout.

Blood R.B.Cs = 1,710,000
Hb = 40%
C.I = 1·2



P.A.

Elsie PRIESTLEY (48)
Holme Villa,
Linthwaite.

Pneumonia five years ago.

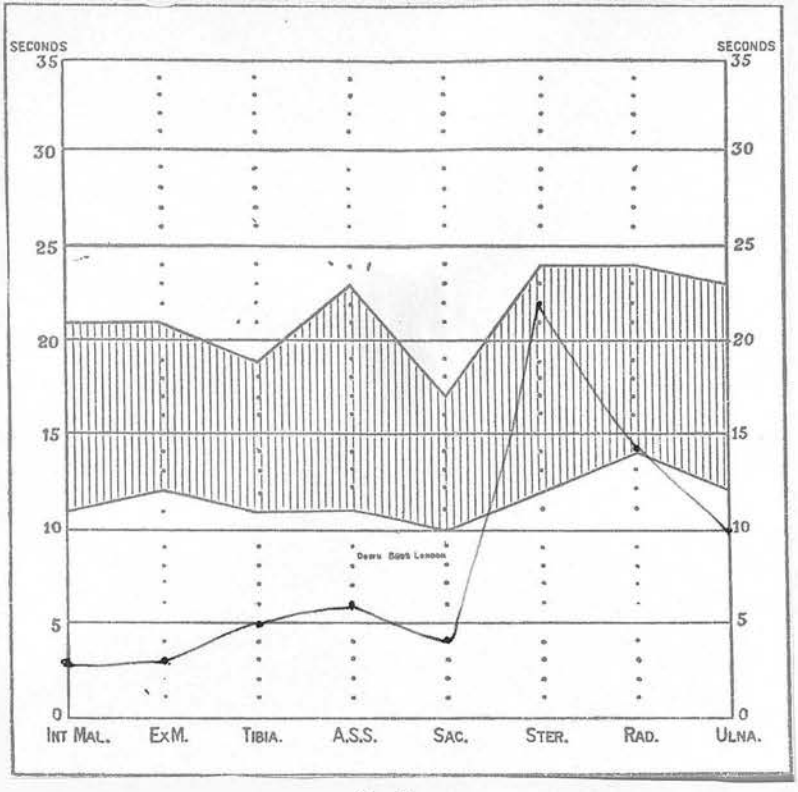
Diabetes.

In 1934 attended again, lemon yellow pallor, dyspnoea, glossitis, paraesthesiae.

Hb = 34%
R.B.C's = 1,600,000
W.B.Cs = 3,000
C.I = 1.1

Films show typical picture of P.A.

Now much improved.



P.A.

Fred RADCLIFFE (53)
5, Lightridge Road,
Huddersfield.

For 4 months before admission complained of flatulence and vague stomach trouble. Progressive weakness. Three weeks before admission legs began to give way, and numbness started.

Reflexes Triceps, brachialis and ankle jerks brisk. Knee jerks absent. Abdominal and cremasteric reflexes absent. Plantar response extensor on right side.

Cranial nerves Pupils sluggish. Deafness in left ear as long as patient can remember. Hearing poor in right ear.

Ataxia Slight in upper limbs, more marked on left. Marked inco-ordination of lower limbs.

Muscles Flexors of right elbow; right wrist extensors and flexors both knees, and all muscles acting on hips, all weak.

Tactile, thermal and pain sensibility absent on left leg. Deep pressure present.

Sense of vibration present, but diminished.

Fundi Arteriosclerotic

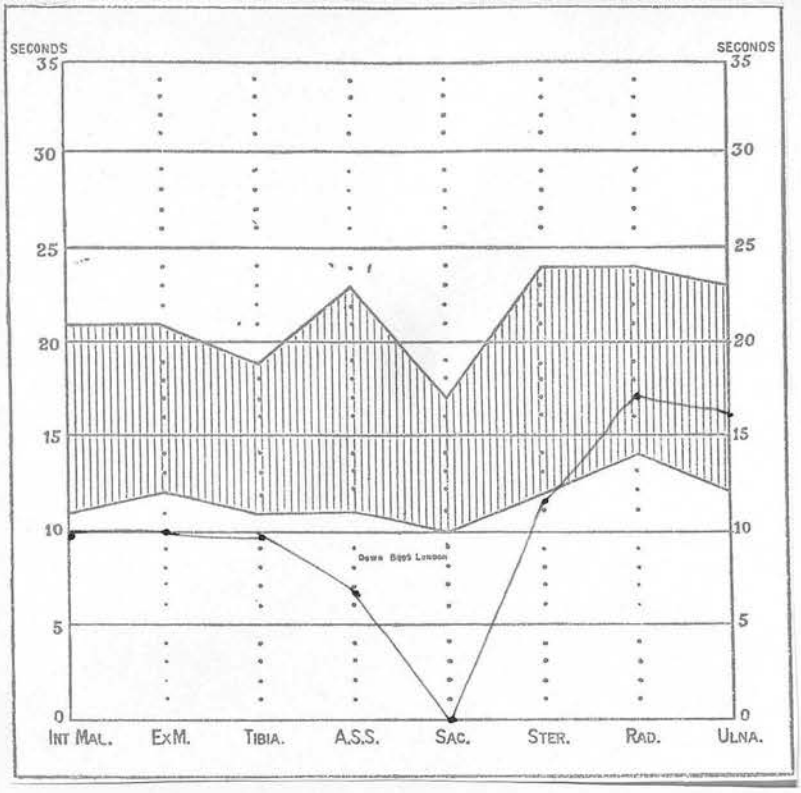
C.S.F. Normal

W.R. Negative

Hypospadias, $\overline{c}$ retention.

Died suddenly.

Blood picture of P.A. Hb = 66%. R.B.Cs = 3,100,000
C.1 = 1·07



P.A.

Sophia RUSHWORTH (62)
18, Waterloo Road,
Brighouse.

Weakness, loss of energy, anorexia very anaemic.

Lemon yellow colour.

Haemic systolic bruits at apex.

Spleen palpable.

Sore tongue.

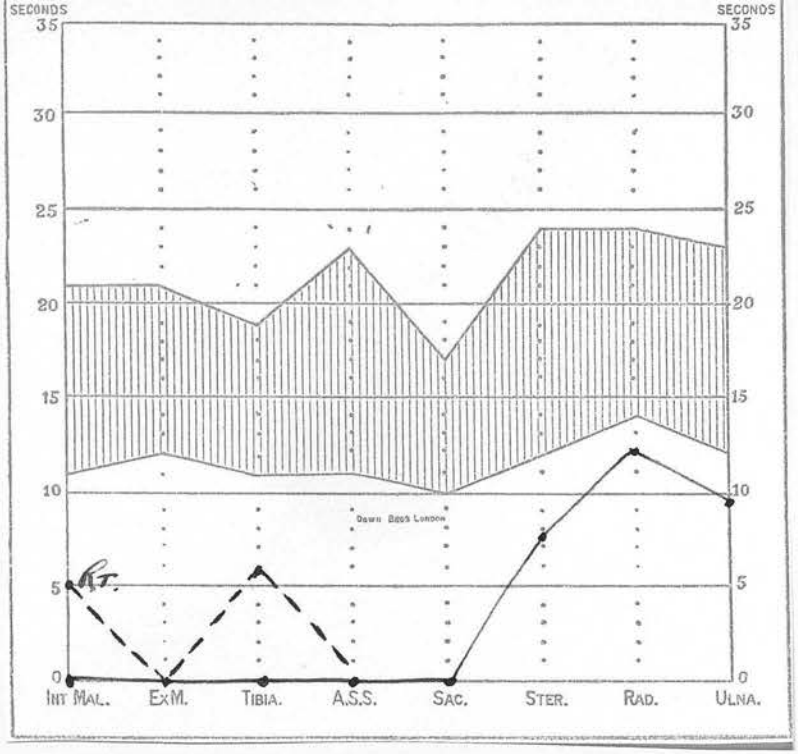
No central nervous system changes, except vibration.

Blood. Hb = 40%
R.B.Cs = 2,060,000
C.I = 1

Films typical.

Complete achlorhydria.

CXXII.



P.A.

Walter SCAIFE (64),
9, Longrove Avenue,
Dalton.

Fourteen weeks ago swelling of left leg. Feet and legs swollen since. Oedema of back and ascites.

Heart. 1st sound in mitral area weak, soft systolic brint.

Aortic diastolic. B.P. $\frac{137}{66}$

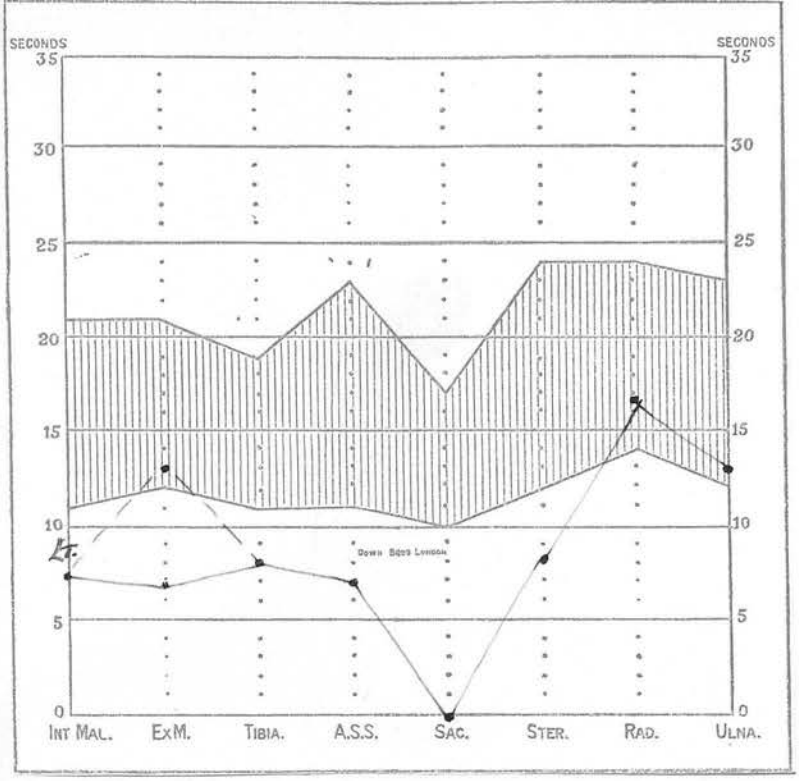
N.P.N. 40 mgms%

Urine Wet films show numerous bacteria, some yeasts and epithelial cells. No casts or pus seen.

Blood count

Hb	60%
R.B.Cs	2,790,000 per cmm.
W.B.Cs	4,400 per cmm.
C.1	1·1

Films show macrocytosis, polychromasia and nucleated reds.



P.A.

Alice TAYLOR (68)
30, Armitage Crescent,
Lockwood.

Severe anaemia for six months.

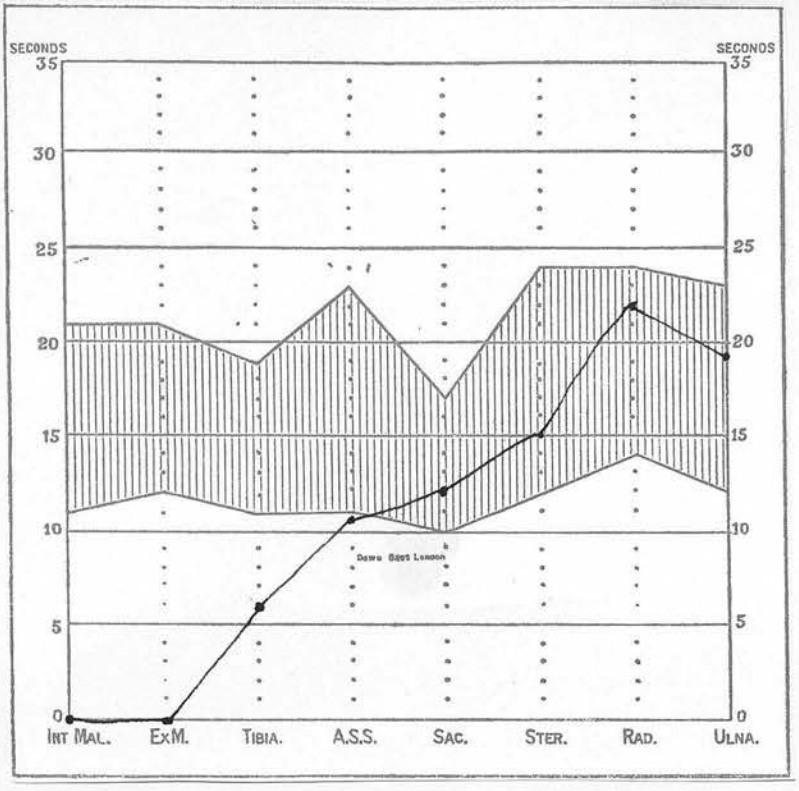
Lemon yellow colour.

dyspnoea.

1934. R.B.Cs = 2,020,000
Hb = 60%
C.1 = 1·5

Films Typical of P.A.

1935. R.B.Cs = 4,760,000
Hb = 74%
C.1 = ·8



P.A.

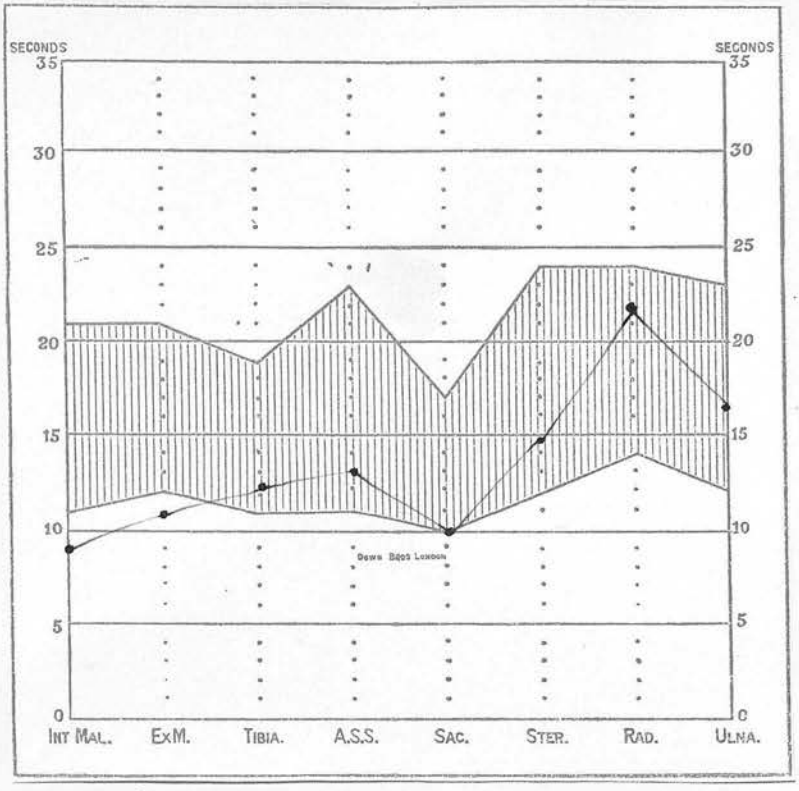
Sarah A. VICKERMAN (46)
23, Hill Top Road,
Paddock.

Hb 38%	R.B.C.	1,920,000	C.I.	= 1·	(11.5.33)
" 90%	"	5,460,000	"	= 0·9	(15.8.33)
" 78%	"	4,820,000	"	= 0·8	(16.7.34)
" 76%	"	4,410,000	"	= 0·9	(6.11.34)
" 42%	"	1,760,000	"	= 1·2	(29.1.35)
" 38%	"	1,420,000	"	= 1·2	(12.2.35)

Started with difficulty in walking in 1926. In 1931 lassitude, dyspnoea. (1933) Lateral nystagnins. Increased knee jerks. Extensor plantar response. Inco-ordination upper limbs. Unable to distinguish hot and cold. Waist band of anaesthesia. Disturbance of joint sense.

Put on Pepsac 16.7.34. Went steadily downhill.

Now much improved, especially cord lesions. Is having pernaemon forte.



P.A.

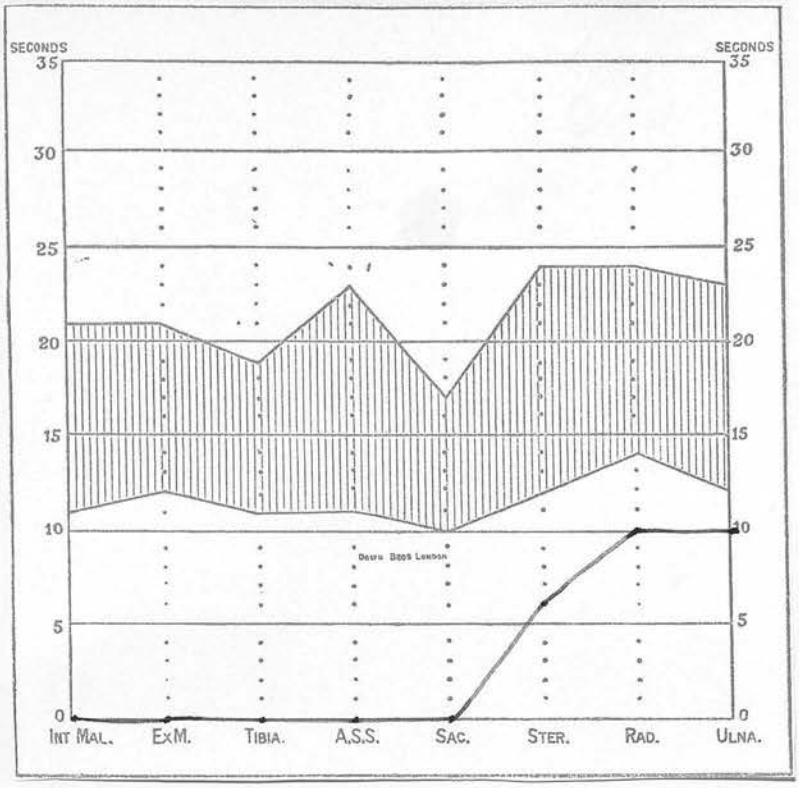
Elvin WHITE (37)
3, Whiteley Street,
Milnsbridge.

Trouble commenced two years ago with loss of appetite and nausea. Glossitis. Pallor, mucous membrane pale! Liver and Spleen not palpable.

Subacute combined sclerosis.

R.B.Cs = 1,250,000
Hb = 32%
C.I = 1·3

Films typical of P.A.



P.A.

Emma WOODHEAD, (55)
22, William Street,
Crosland Moor.

Spastic paraplegia , with inability to walk.

Typical P.A. picture.

Lungs, Heart, N.A.D.

Reflexes + +

Sensation diminished
Double plantar extensor.

Muscles respond normally to faradism.

C.S.F. normal

Total achlorhydria.

Blood count

Hb = 68%
R.B.Cs = 4,820,000
W.B.Cs = 6,400
C.I. = .8
Polymo. = 54%
Lymph. = 37%
Eos. = 5%
Bas. = 1%
Transit. = 3%